# ColdBox Jan-2024 Data analysis (membrane detectors)

Dante, Ajib
Feb 23, 2024

# Overview

**Membrane Modules (HD- VD-style CE) with DAPHNE r/o data:**

→ Continuing Analysis from the presentation on Friday 15, 2024

→ SNR Amplitude study as fcn of Moving Avg parameter

→Some histograms: SPE, RMS, SNR  vs DAPHNE/AFE Gain setting (change Attenuation stage setting)

→ SNR Integral study as a function of integration window

→ SNR vs DAPHNE/AFE Gain setting

SNR Amplitude study as fcn of Moving Avg parameter

→Some histograms: SPE, RMS, SNR  vs DAPHNE/AFE Gain setting (change Attenuation stage setting)

Table 1

| Run # | AFE setting VGAIN [DAC] | $V_{CNTL\ (P\text{-}M)}$ [V] VGAIN 2666 = 1V Vcntrl | Tot Gain [db] LNA+VCAT+PGA (12db+VCAT+24db) | Atten [db] VCAT (only) | Tot Gain factor (db->Out/In) | Atten factor (db->Out/In) |
|---|---|---|---|---|---|---|
| **24037** | 600 | 0.23 | 29.6 | -6.4 | 30.3 | 0.48 |
| **24089** | 1330 | 0.50 | 20.4 | -15.6 | 10.4 | 0.17 |
| **24097** | 1860 | 0.70 | 13.6 | -22.4 | 4.8 | 0.08 |
| **24062** | 1925 | 0.72 | 12.8 | -23.2 | 4.4 | 0.07 |

# DAPHNE/AFE Gain Settings

- data taken w/ 4 different AFE Gain Settings:
  - Tot Gain established by combination of 3 stages of Gain/Attenuation
  - Different Tot Gain in CB runs by changing Attenuation stage VCAT (and fixed two Gain Stages - LNA, PGA)

TEXAS INSTRUMENTS

AFE5808A

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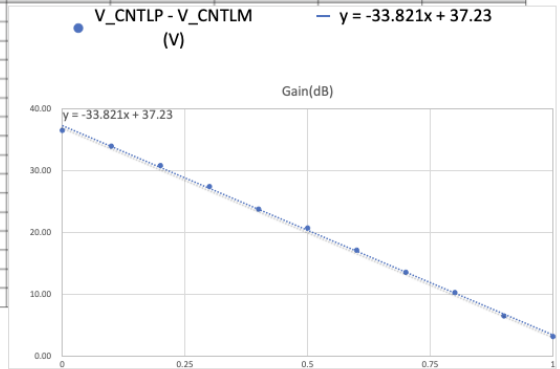
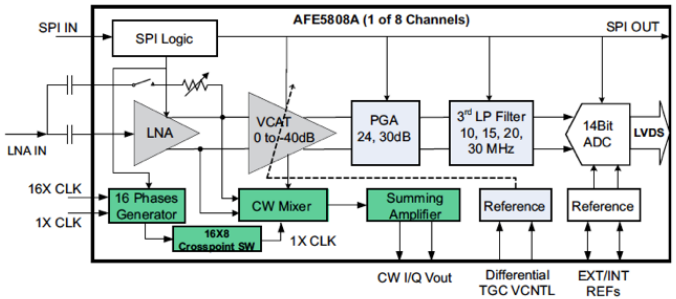
**Table 16. $V_{CNTLP}$–$V_{CNTLM}$ vs Gain Under Different LNA and PGA Gain Settings (Low Noise Mode)**

| $V_{CNTLP} - V_{CNTLM}$ (V) | Gain (dB) LNA = 12 dB PGA = 24 dB | Gain (dB) LNA = 18 dB PGA = 24 dB | Gain (dB) LNA = 24 dB PGA = 24 dB | Gain (dB) LNA = 12 dB PGA = 30 dB | Gain (dB) LNA = 18 dB PGA = 30 dB | Gain (dB) LNA = 24 dB PGA = 30 dB |
|---|---|---|---|---|---|---|
| 0 | 36.45 | | | | | |
| 0.1 | 33.91 | | | | | |
| 0.2 | 30.78 | | | | | |
| 0.3 | 27.39 | | | | | |
| 0.4 | 23.74 | | | | | |
| 0.5 | 20.69 | | | | | |
| 0.6 | 17.11 | | | | | |
| 0.7 | 13.54 | | | | | |
| 0.8 | 10.27 | | | | | |
| 0.9 | 6.48 | | | | | |
| 1 | 3.16 | | | | | |
| 1.1 | –0.35 | | | | | |
| 1.2 | –2.48 | | | | | |
| 1.3 | –3.58 | | | | | |
| 1.4 | –4.01 | | | | | |
| 1.5 | –4 | | | | | |



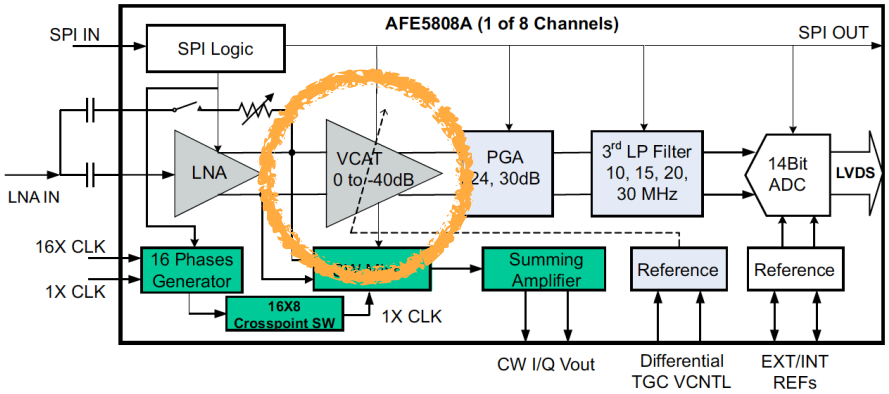

## AFE5808A Block Diagram

- No LowPass Filter ON in these runs




LNA = Low Noise Amplifier; VCAT = Voltage Controlled Attenuator; PGA = Programmable Gain Amplifier;

**Functional Block Diagram**

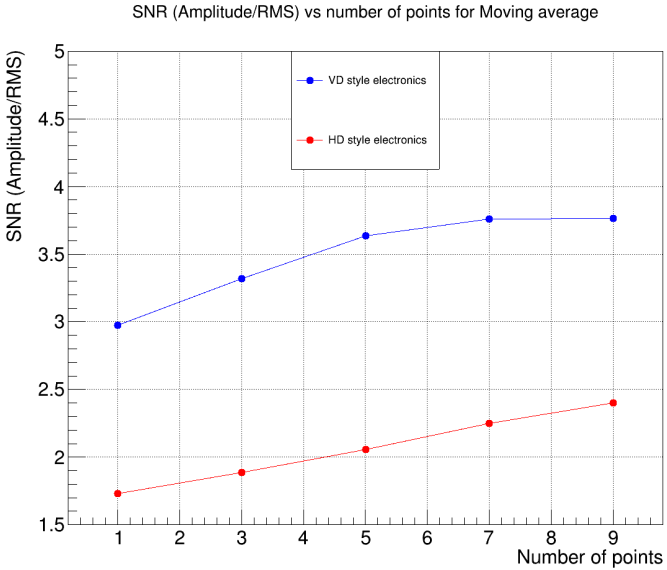



## Table 1. Voltage-Controlled-Attenuator Noise vs Attenuation

| ATTENUATION (dB) | ATTENUATOR INPUT REFERRED NOISE ($nV/\sqrt{Hz}$) |
|---|---|
| –40 | 10.5 |
| –36 | 10 |
| –30 | 9 |
| –24 | 8.5 |
| –18 | 6 |
| –12 | 4 |
| –6 | 3 |

# SNR [Amplitude/RMS] vs Moving average

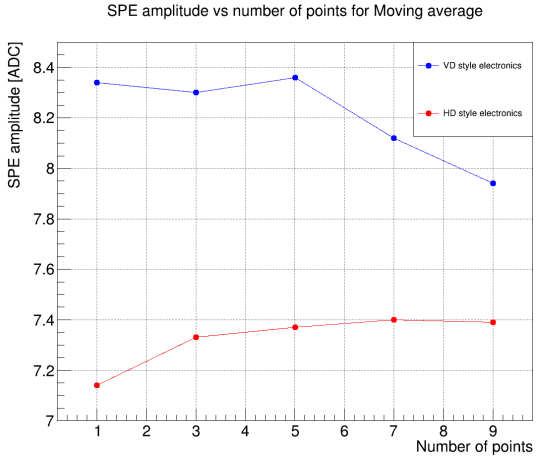
## Run 24062 [AFE->1925] - (Min Gain Factor - 4.4x )

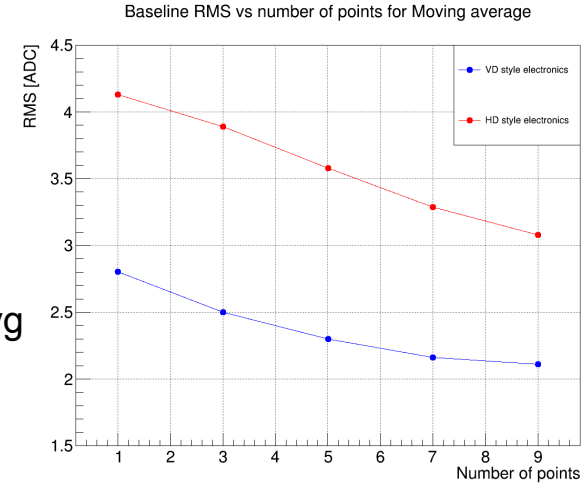



No of points is the total number of points for which moving average is estimated. E.g., no of points = 3 ⇒1 point before and 1 point after the reference point.

No of points = 1 for raw waveform.

Only moving average is used, no other filtering is applied.



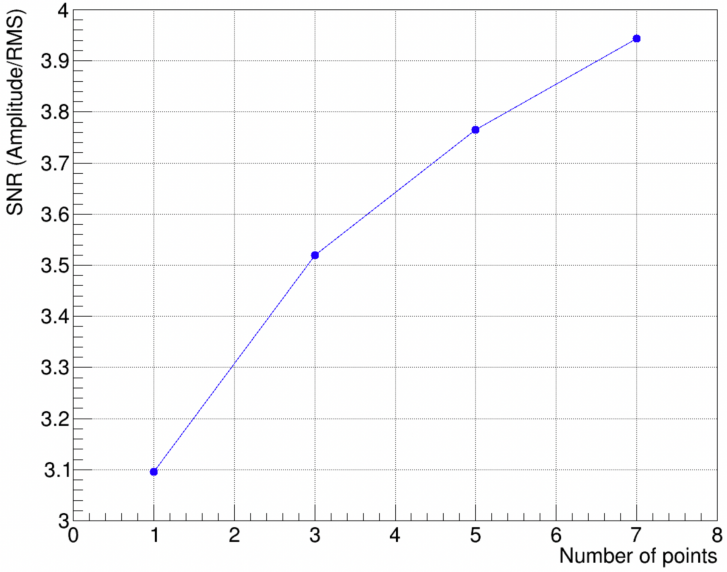

**SNR_A = Ampitude/RMS**

NOTE: n=3, 5, 7 points Moving Avg ~corresponds to LowPass Filter 20,15, 10 MHz available on DAPHNE/AFE

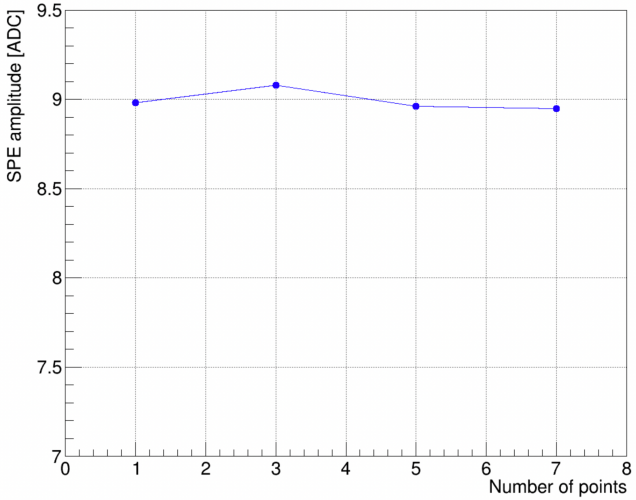
SNR [Amplitude/RMS] vs Moving average

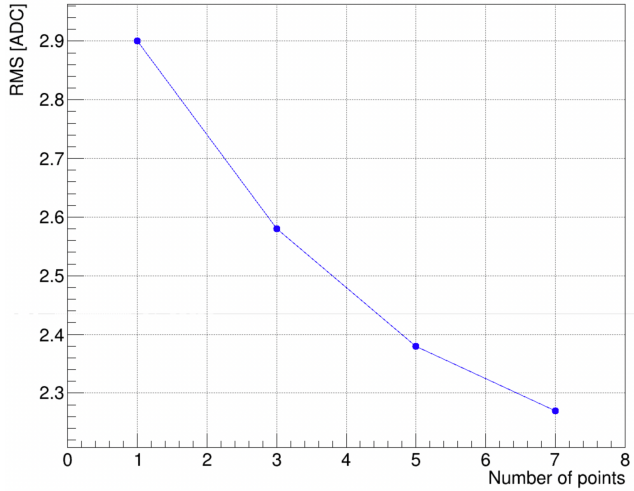
**Run 24097 AFE→1860 (Low Gain Factor 4.8x)**

**[VD only plots]**




analysis not done for HD due to high noise.



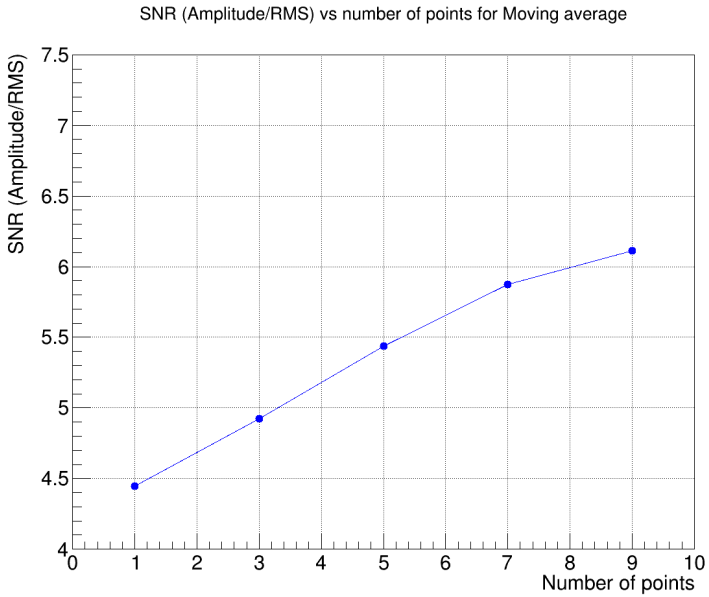




**SNR_A = Ampitude/RMS**

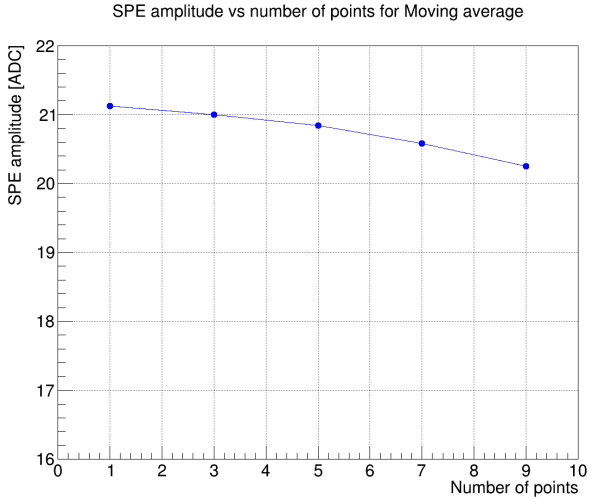
# SNR [Amplitude/RMS] vs Moving average

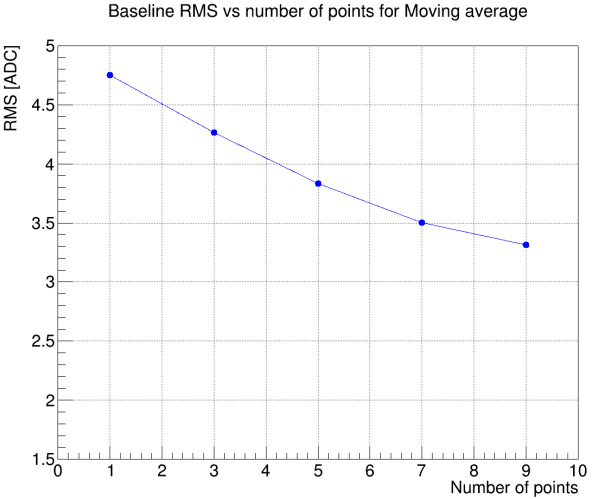
## Run 24089 AFE→1330 (high Gain Factor 10.4x)

## [VD only plots]




ALL PLOTS ARE FOR VD; This run has high noise for HD making the RMS values unmeasurable; (hence I did not do a complete study for HD).



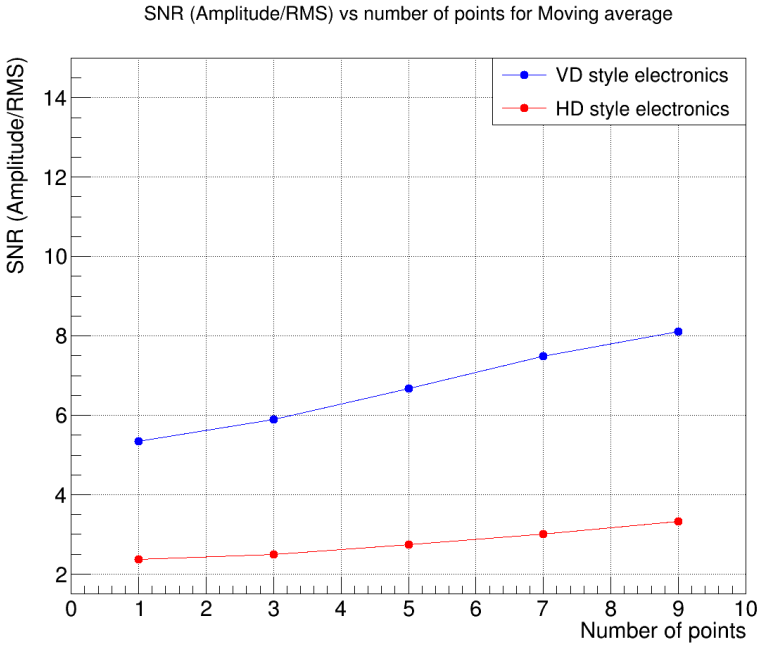




**SNR_A = Ampitude/RMS**

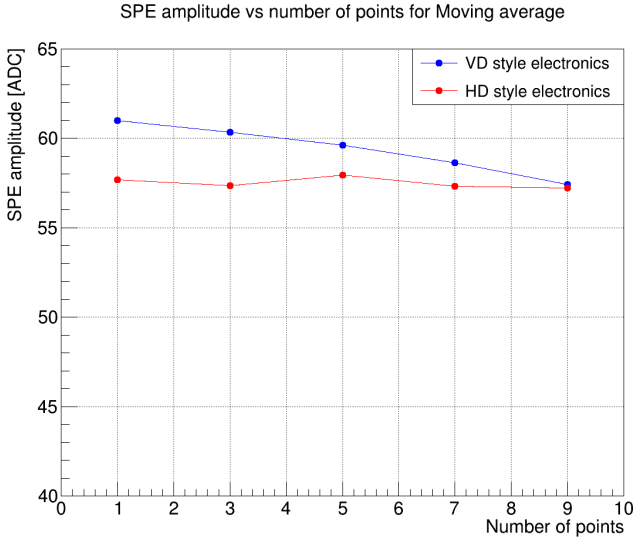
SNR [Amplitude/RMS] vs Moving average

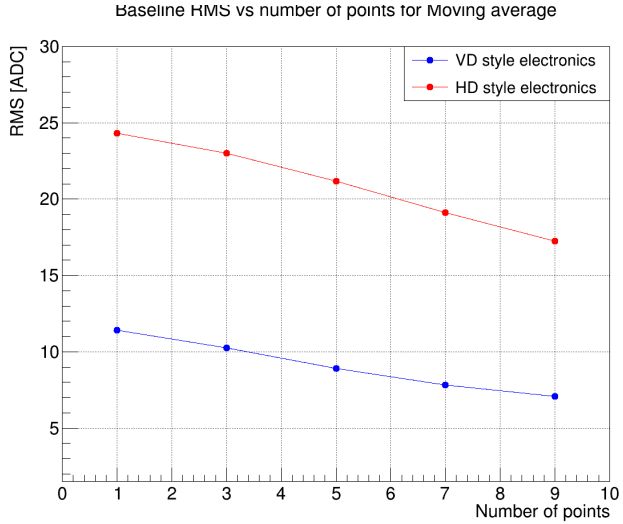
# Run 24037 [AFE setting 600] (Max Gain 30.3x)

# [VD and HD plots]

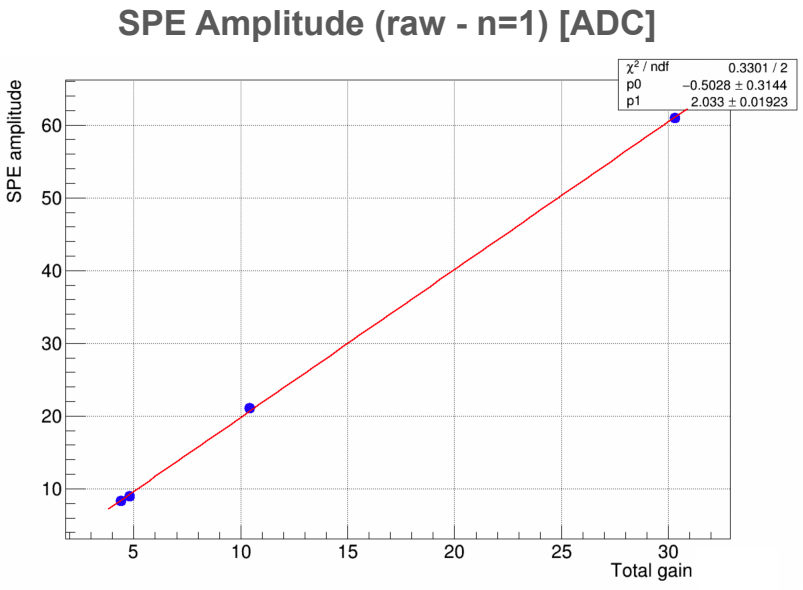


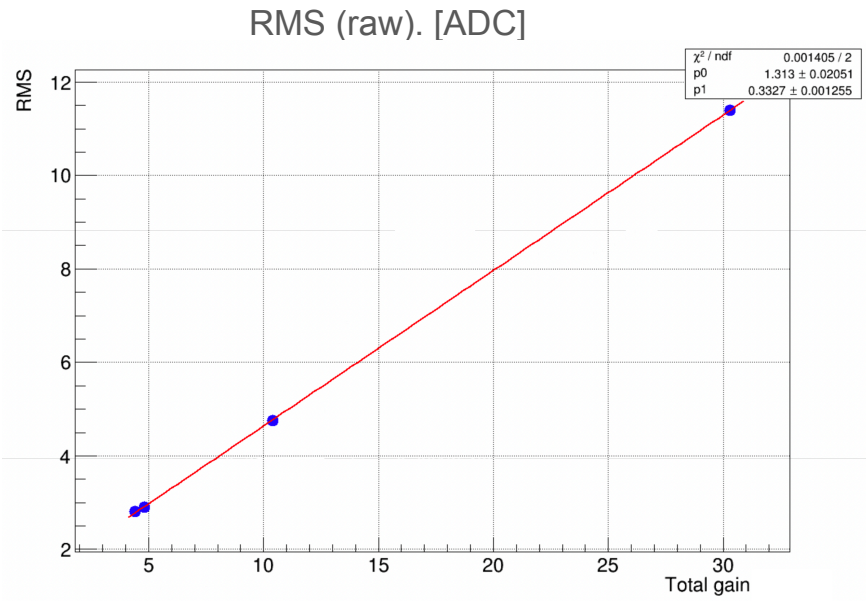

**SNR_A = Ampitude/RMS**



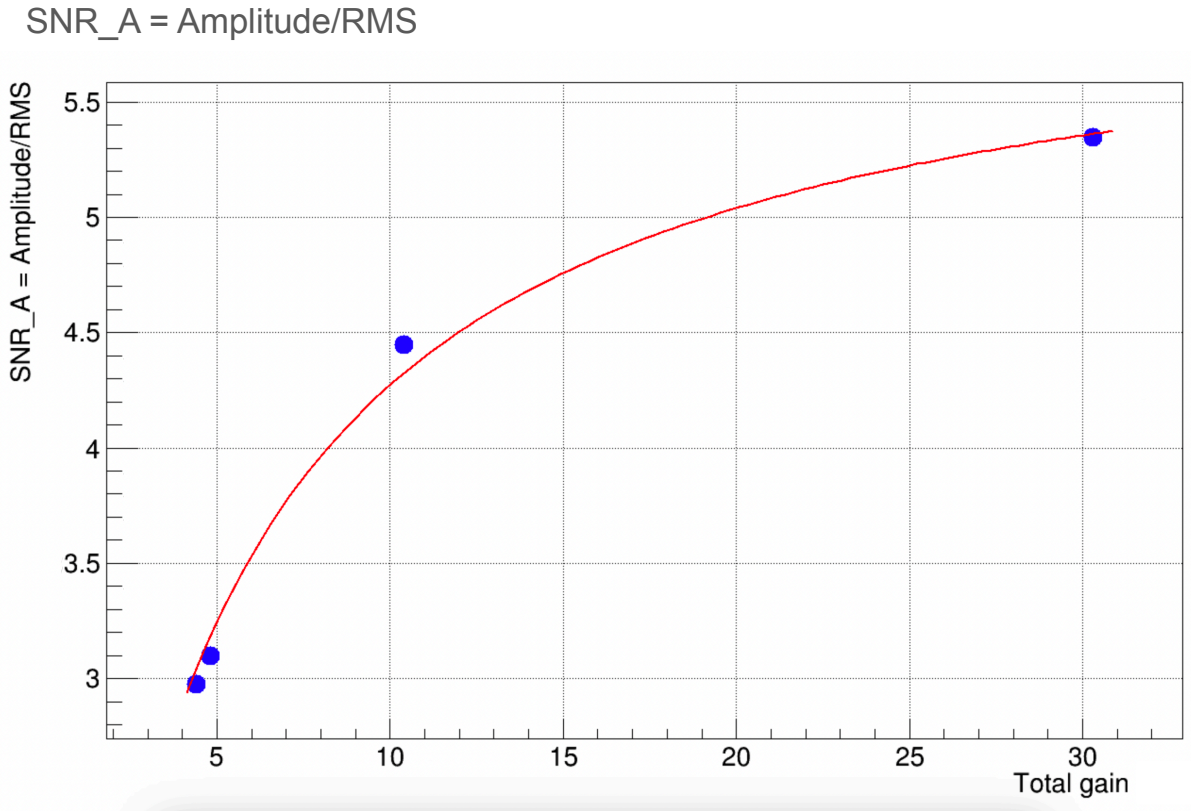
# SNR-A, SPE-A, RMS vs Gain (VD style data only shown):




Both Signal A and Noise RMS Signal increase linearly with Gain

Signal A increases faster than Noise as a function of gain




**[VD only data]**

**Red curve = (a+bx)/(c+dx)**
**(a,b, c, d are parameters from SPE-A, Noise-RMS fits)**

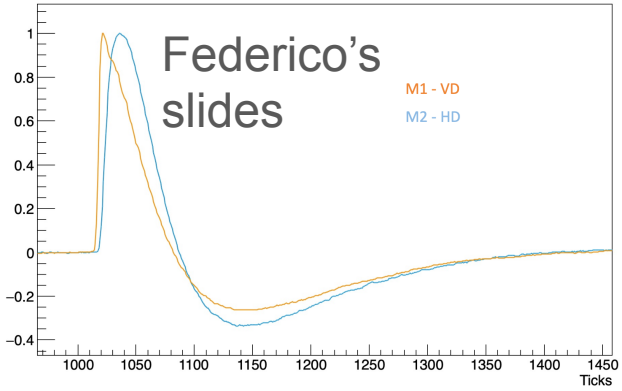
SNR increases with Gain

SNR Integral study as a function of integration window

→ SNR vs DAPHNE/AFE Gain setting

# SNR vs integration window Width for the 4 Runs at different Gain

Integration window starts immediately before the pulse rising edge. Since the VD rising edge is faster than the HD rising edge, the starting point is not the same:




Pulse rising edge(from Federico's slides):

**HD: 150 ns**

**VD: 65 ns**

Integration window starting point:

**HD: 20** ticks before the max

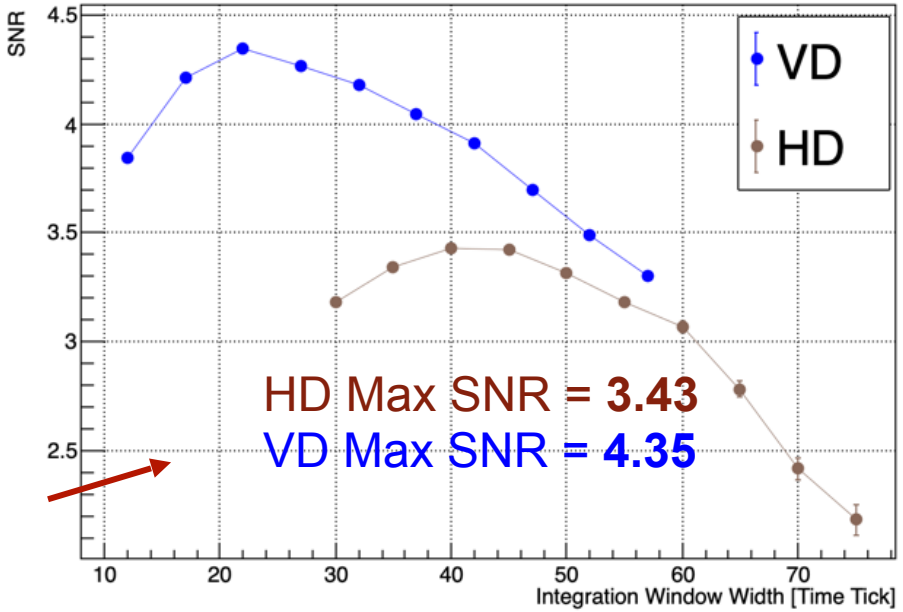
**VD: 12** ticks before the max

SNR is defined as the separation between the mean of the PE peaks integral divided by the standard deviation of the 0 PE peak.

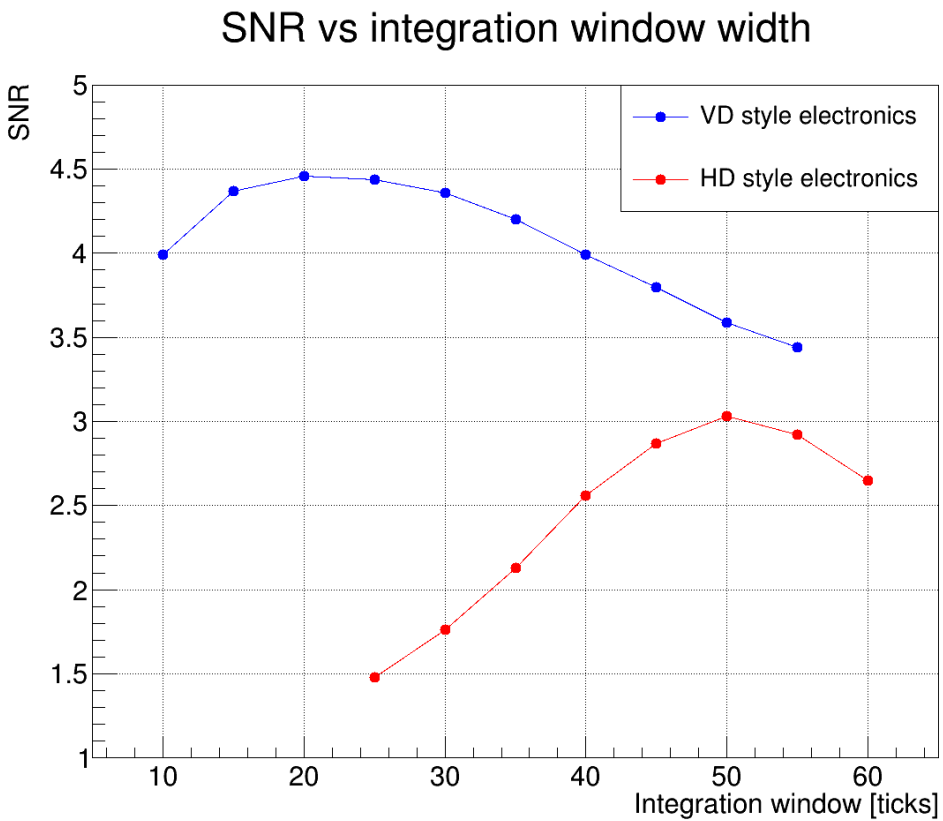
A study of the SNR vs integration window width is made.

Slide presented by Dante last week

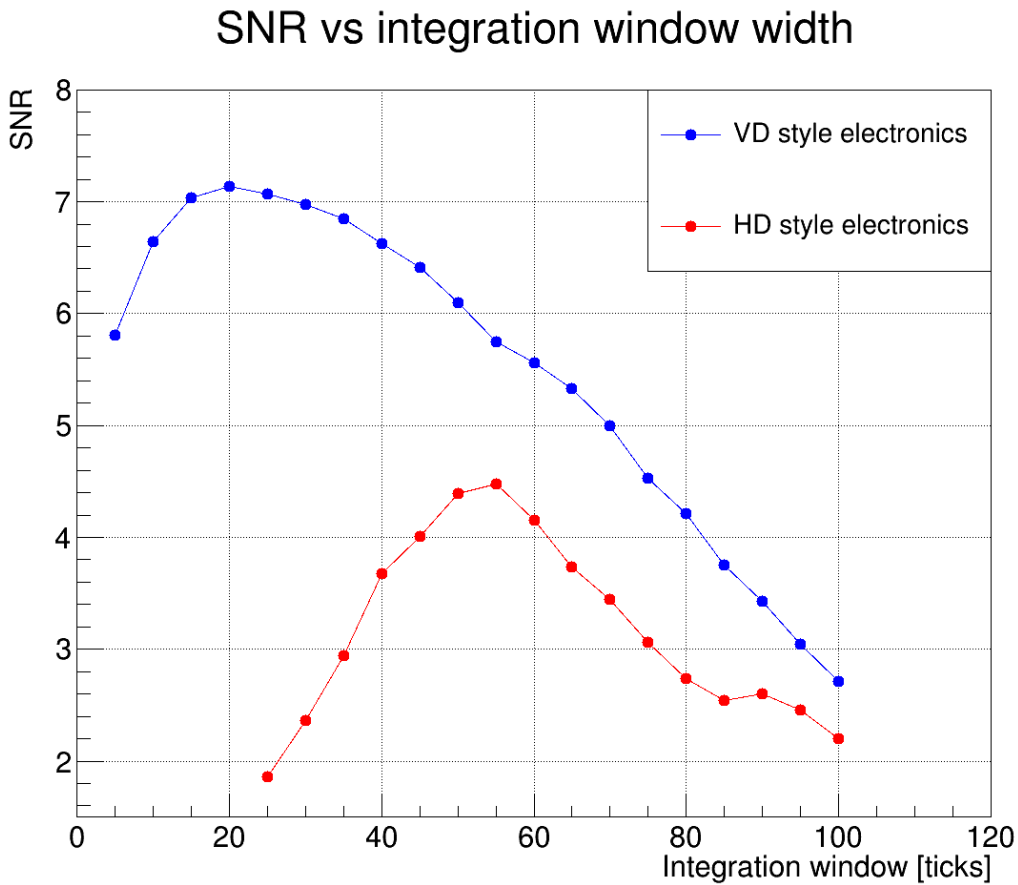
**Run 24062 [AFE->1925] - (Min Gain Factor - 4.4x )**



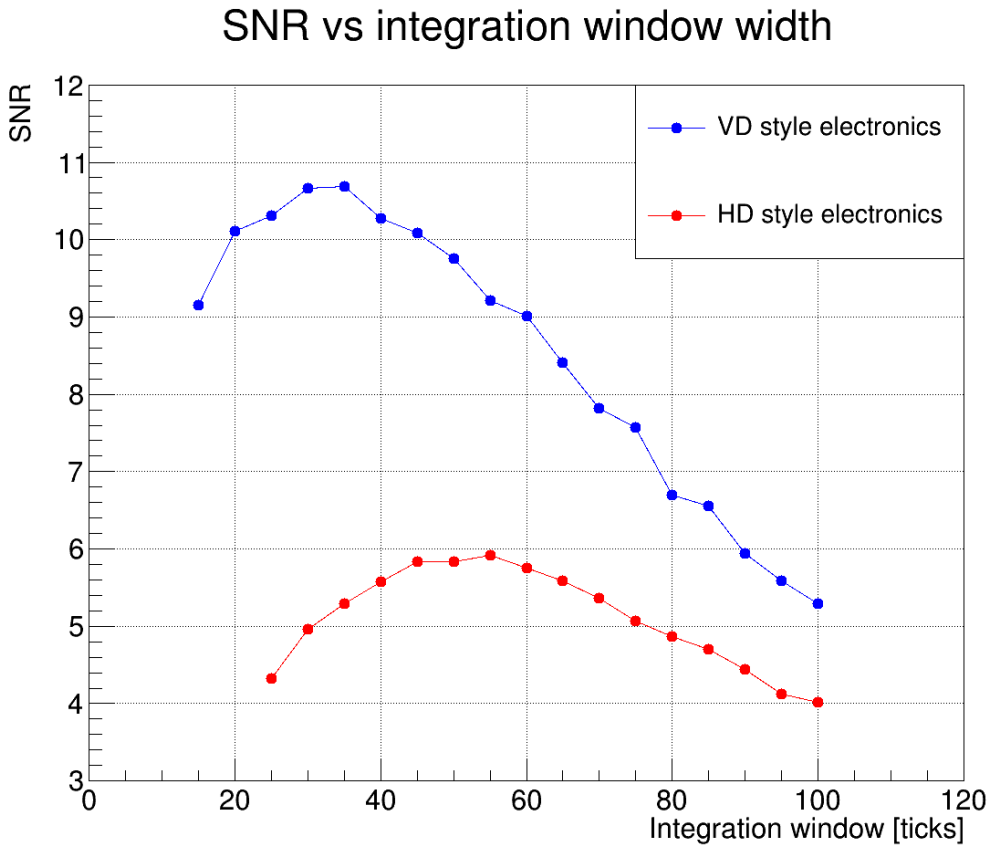
# Run 24097 AFE→1860 (Low Gain Factor  4.8x)



# Run 24089 AFE→1330 (high Gain Factor 10.4x)

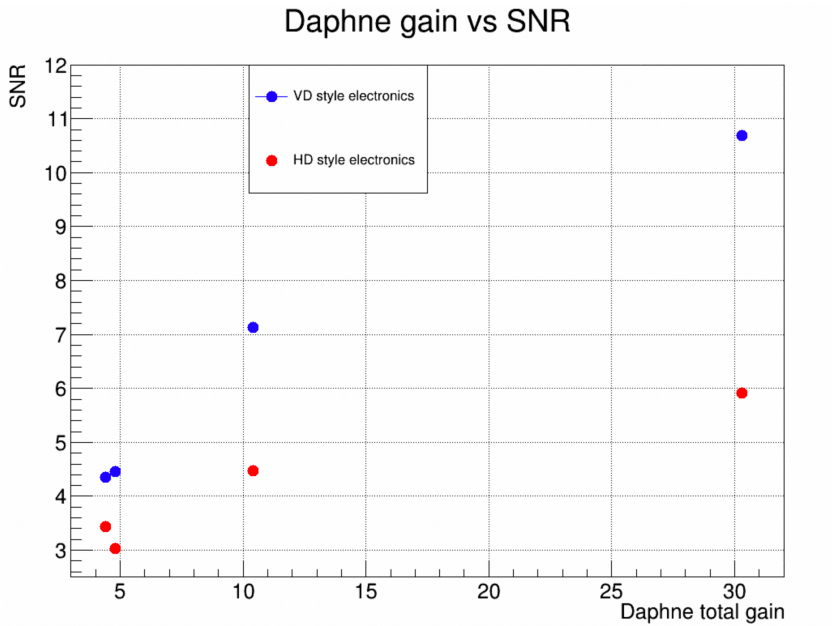


# Run 24037 [AFE setting 600] (Max Gain 30.3x)

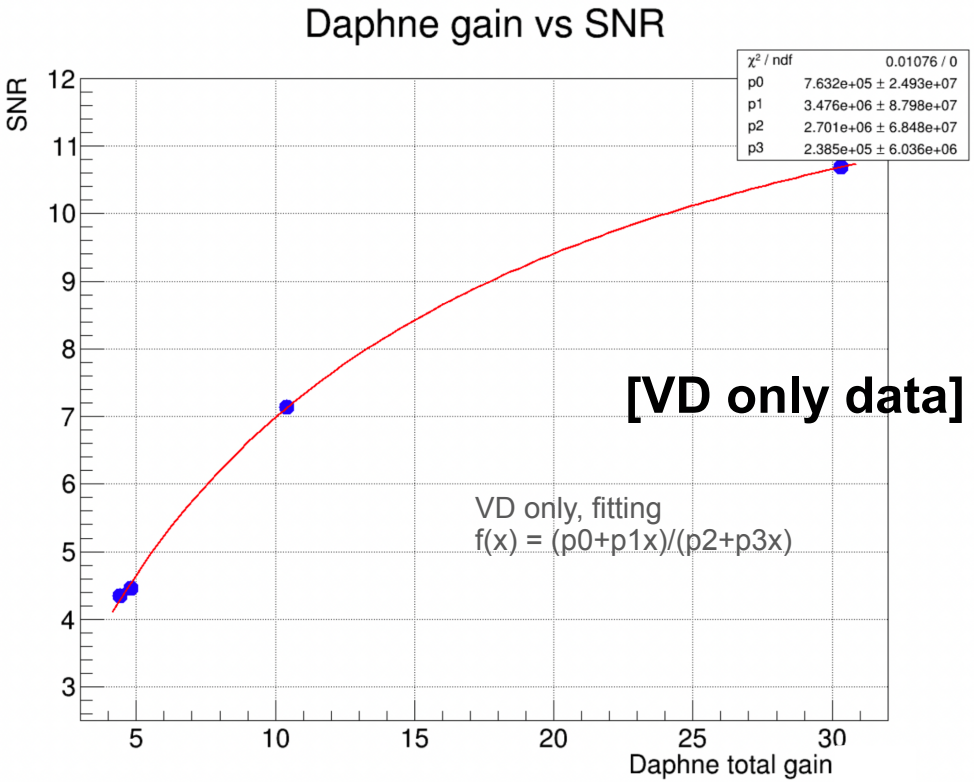


Summarizing the integral SNR study.

**[VD and HD data]**




Plot shows SNR from integral (charge) as a function of DAPHNE/AFE total gain.

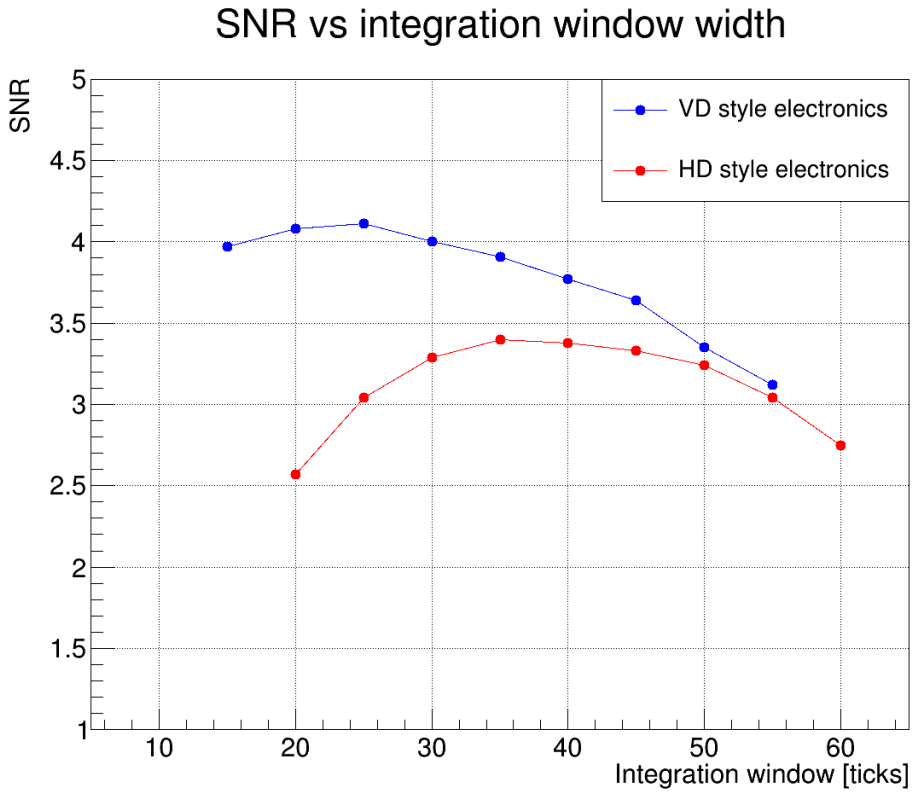


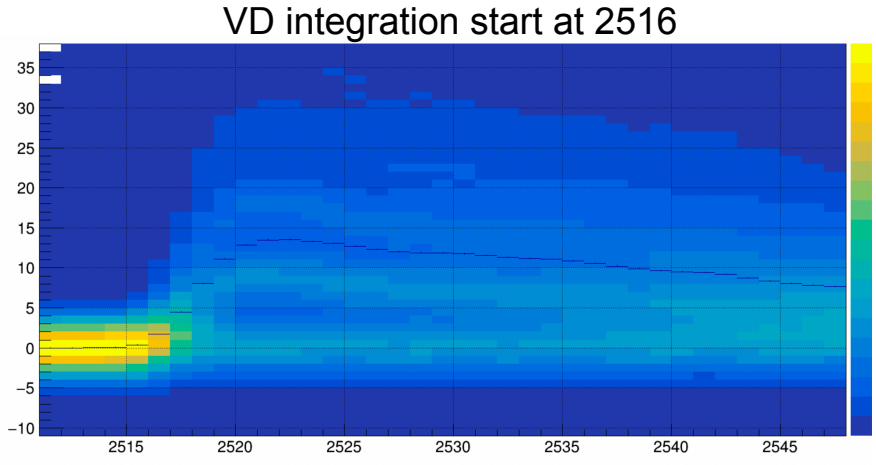

SNR increases with Gain

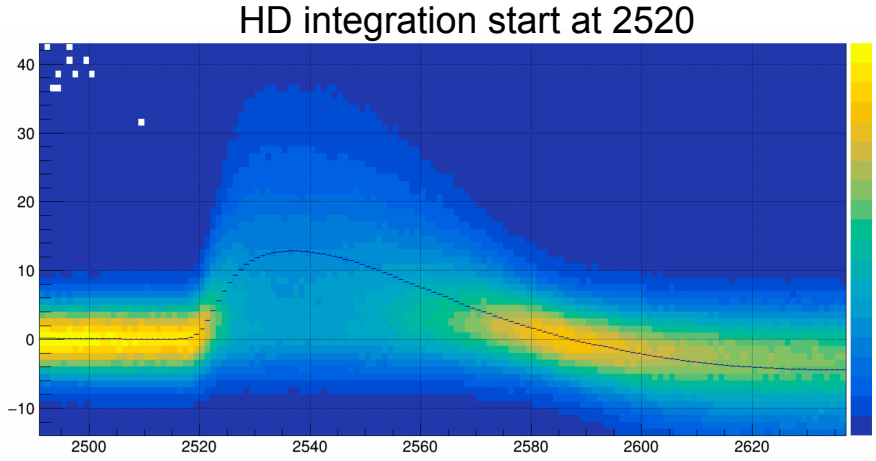
as also noticed with SNR-Amplitude study

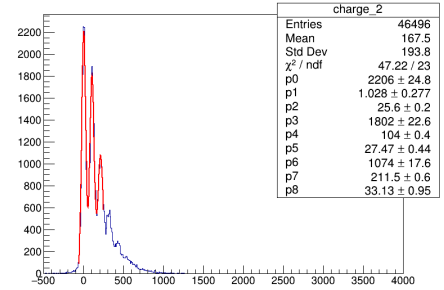
BackUp Slides

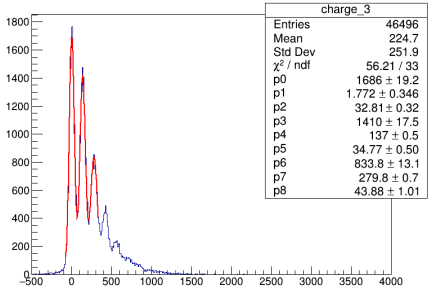
Run 24062 Integral Analysis by Ajib

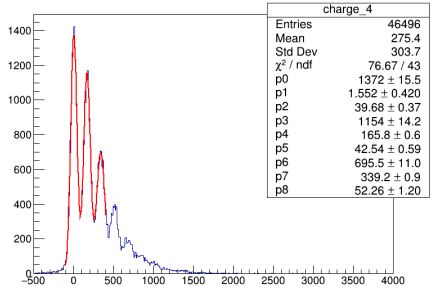


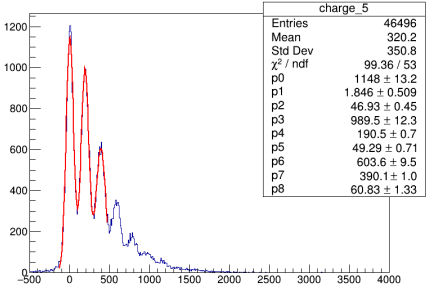



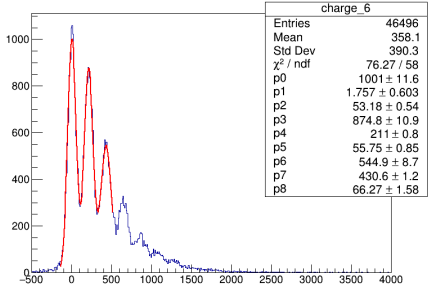

charge_2
Entries 46496
Mean 167.5
Std Dev 193.8
χ² / ndf 47.22 / 23
p0 2206 ± 24.8
p1 1.028 ± 0.277
p2 25.6 ± 0.2
p3 1802 ± 22.6
p4 104 ± 0.4
p5 27.47 ± 0.44
p6 1074 ± 17.6
p7 211.5 ± 0.6
p8 33.13 ± 0.95

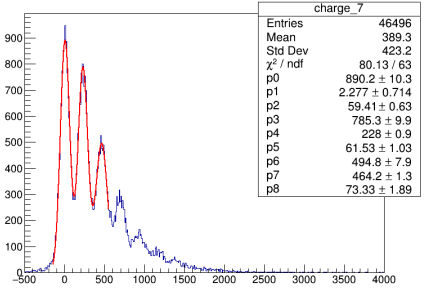

charge_3
Entries 46496
Mean 224.7
Std Dev 251.9
χ² / ndf 56.21 / 33
p0 1686 ± 19.2
p1 1.772 ± 0.346
p2 32.81 ± 0.32
p3 1410 ± 17.5
p4 137 ± 0.5
p5 34.77 ± 0.50
p6 833.8 ± 13.1
p7 279.8 ± 0.7
p8 43.88 ± 1.01

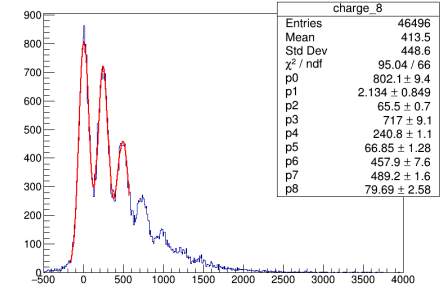

charge_4
Entries 46496
Mean 275.4
Std Dev 303.7
χ² / ndf 76.67 / 43
p0 1372 ± 15.5
p1 1.552 ± 0.420
p2 39.68 ± 0.37
p3 1154 ± 14.2
p4 165.8 ± 0.6
p5 42.54 ± 0.59
p6 695.5 ± 11.0
p7 339.2 ± 0.9
p8 52.26 ± 1.20

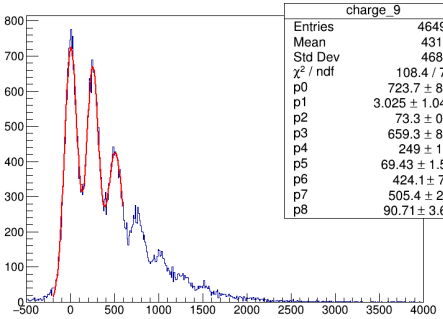
Run 24062 VD

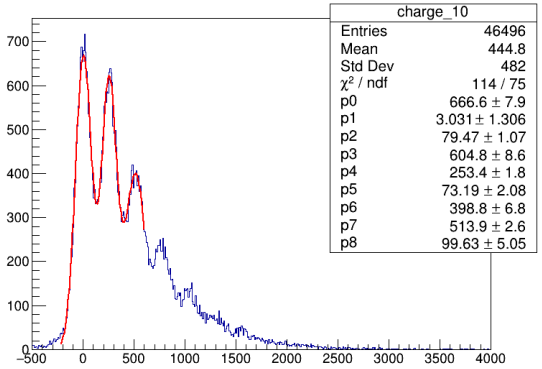

charge_5
Entries 46496
Mean 320.2
Std Dev 350.8
χ² / ndf 99.36 / 53
p0 1148 ± 13.2
p1 1.846 ± 0.509
p2 46.93 ± 0.45
p3 989.5 ± 12.3
p4 190.5 ± 0.7
p5 49.29 ± 0.71
p6 603.6 ± 9.5
p7 390.1 ± 1.0
p8 60.83 ± 1.33

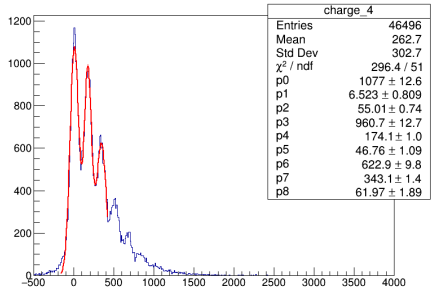

charge_6
Entries 46496
Mean 358.1
Std Dev 390.3
χ² / ndf 76.27 / 58
p0 1001 ± 11.6
p1 1.757 ± 0.603
p2 53.18 ± 0.54
p3 874.8 ± 10.9
p4 211 ± 0.8
p5 55.75 ± 0.85
p6 544.9 ± 8.7
p7 430.6 ± 1.2
p8 66.27 ± 1.58

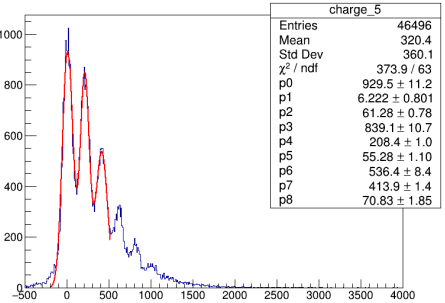

charge_7
Entries 46496
Mean 389.3
Std Dev 423.2
χ² / ndf 80.13 / 63
p0 890.2 ± 10.3
p1 2.277 ± 0.714
p2 59.41 ± 0.63
p3 785.3 ± 9.9
p4 228 ± 0.9
p5 61.53 ± 1.03
p6 494.8 ± 7.9
p7 464.2 ± 1.3
p8 73.33 ± 1.89

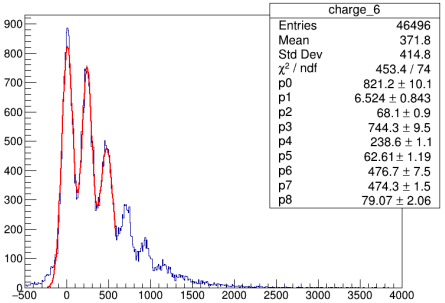

charge_8
Entries 46496
Mean 413.5
Std Dev 448.6
χ² / ndf 95.04 / 66
p0 802.1 ± 9.4
p1 2.134 ± 0.849
p2 65.5 ± 0.7
p3 717 ± 9.1
p4 240.8 ± 1.1
p5 66.85 ± 1.28
p6 457.9 ± 7.6
p7 489.2 ± 1.6
p8 79.69 ± 2.58


charge_9
Entries 46496
Mean 431.9
Std Dev 468.2
χ² / ndf 108.4 / 72
p0 723.7 ± 8.5
p1 3.025 ± 1.043
p2 73.3 ± 0.9
p3 659.3 ± 8.6
p4 249 ± 1.4
p5 69.43 ± 1.58
p6 424.1 ± 7.1
p7 505.4 ± 2.0
p8 90.71 ± 3.64

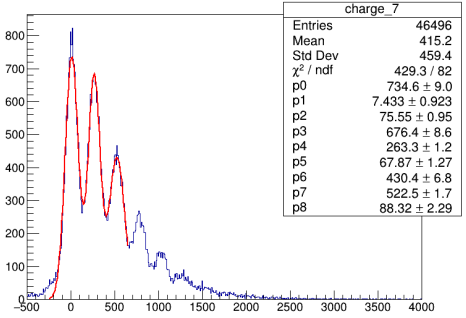

charge_10
Entries 46496
Mean 444.8
Std Dev 482
χ² / ndf 114 / 75
p0 666.6 ± 7.9
p1 3.031 ± 1.306
p2 79.47 ± 1.07
p3 604.8 ± 8.6
p4 253.4 ± 1.8
p5 73.19 ± 2.08
p6 398.8 ± 6.8
p7 513.9 ± 2.6
p8 99.63 ± 5.05

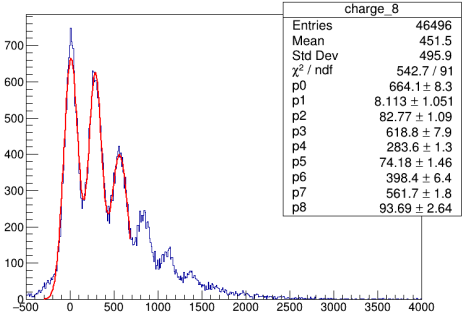

charge_4
Entries 46496
Mean 262.7
Std Dev 302.7
χ² / ndf 296.4 / 51
p0 1077 ± 12.6
p1 6.523 ± 0.809
p2 55.01 ± 0.74
p3 960.7 ± 12.7
p4 174.1 ± 1.0
p5 46.76 ± 1.09
p6 622.9 ± 9.8
p7 343.1 ± 1.4
p8 61.97 ± 1.89

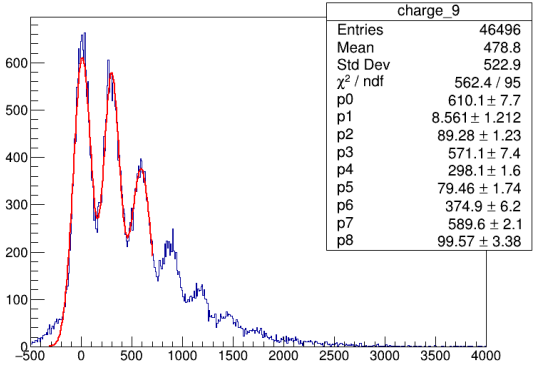

charge_5
Entries 46496
Mean 320.4
Std Dev 360.1
χ² / ndf 373.9 / 63
p0 929.5 ± 11.2
p1 6.222 ± 0.801
p2 61.28 ± 0.78
p3 839.1 ± 10.7
p4 208.4 ± 1.0
p5 55.28 ± 1.10
p6 536.4 ± 8.4
p7 413.9 ± 1.4
p8 70.83 ± 1.85

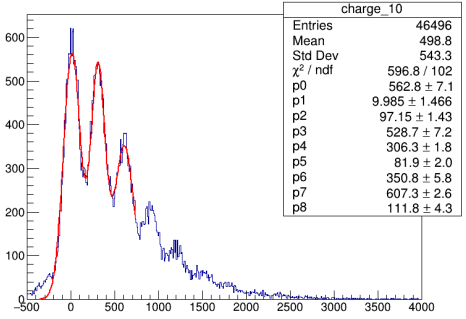

charge_6
Entries 46496
Mean 371.8
Std Dev 414.8
χ² / ndf 453.4 / 74
p0 821.2 ± 10.1
p1 6.524 ± 0.843
p2 68.1 ± 0.9
p3 744.3 ± 9.5
p4 238.6 ± 1.1
p5 62.61 ± 1.19
p6 476.7 ± 7.5
p7 474.3 ± 1.5
p8 79.07 ± 2.06

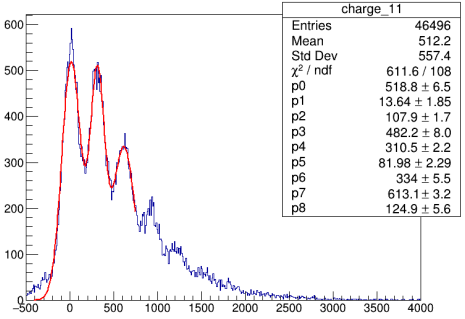
Run 24062 HD

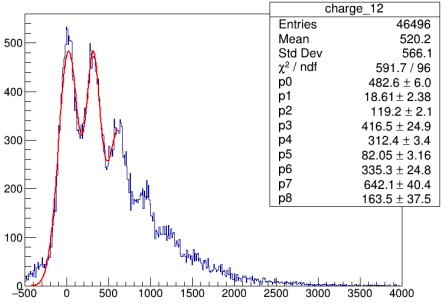

charge_7
Entries 46496
Mean 415.2
Std Dev 459.4
χ² / ndf 429.3 / 82
p0 734.6 ± 9.0
p1 7.433 ± 0.923
p2 75.55 ± 0.95
p3 676.4 ± 8.6
p4 263.3 ± 1.2
p5 67.87 ± 1.27
p6 430.4 ± 6.8
p7 522.5 ± 1.7
p8 88.32 ± 2.29

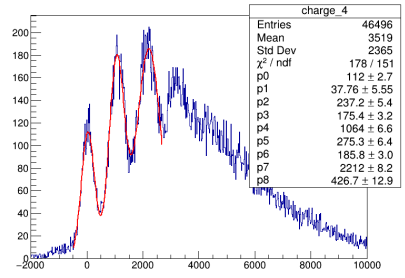

charge_8
Entries 46496
Mean 451.5
Std Dev 495.9
χ² / ndf 542.7 / 91
p0 664.1 ± 8.3
p1 8.113 ± 1.051
p2 82.77 ± 1.09
p3 618.8 ± 7.9
p4 283.6 ± 1.3
p5 74.18 ± 1.46
p6 398.4 ± 6.4
p7 561.7 ± 1.8
p8 93.69 ± 2.64

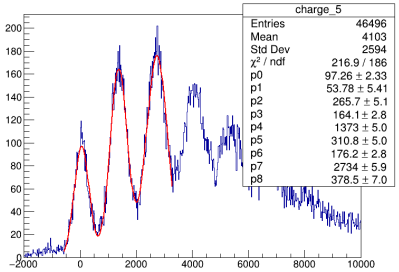

charge_9
Entries 46496
Mean 478.8
Std Dev 522.9
χ² / ndf 562.4 / 95
p0 610.1 ± 7.7
p1 8.561 ± 1.212
p2 89.28 ± 1.23
p3 571.1 ± 7.4
p4 298.1 ± 1.6
p5 79.46 ± 1.74
p6 374.9 ± 6.2
p7 589.6 ± 2.1
p8 99.57 ± 3.38

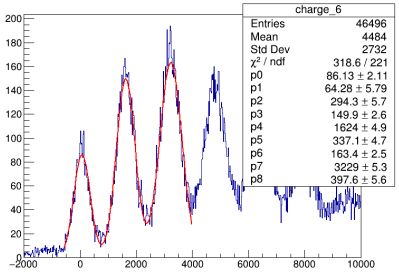

charge_10
Entries 46496
Mean 498.8
Std Dev 543.3
χ² / ndf 596.8 / 102
p0 562.8 ± 7.1
p1 9.985 ± 1.466
p2 97.15 ± 1.43
p3 528.7 ± 7.2
p4 306.3 ± 1.8
p5 81.9 ± 2.0
p6 350.8 ± 5.8
p7 607.3 ± 2.6
p8 111.8 ± 4.3

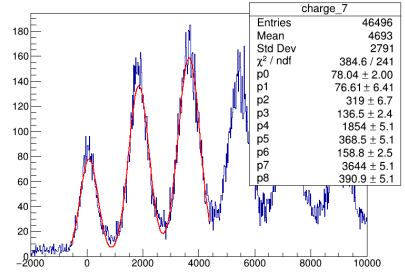

charge_11
Entries 46496
Mean 512.2
Std Dev 557.4
χ² / ndf 611.6 / 108
p0 518.8 ± 6.5
p1 13.64 ± 1.85
p2 107.9 ± 1.7
p3 482.2 ± 8.0
p4 310.5 ± 2.2
p5 81.98 ± 2.29
p6 334 ± 5.5
p7 613.1 ± 3.2
p8 124.9 ± 5.6

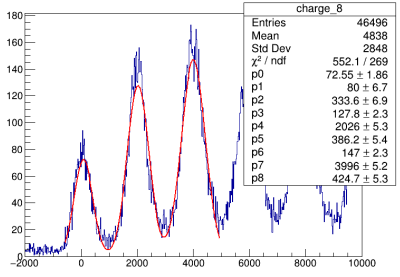

charge_12
Entries 46496
Mean 520.2
Std Dev 566.1
χ² / ndf 591.7 / 96
p0 482.6 ± 6.0
p1 18.61 ± 2.38
p2 119.2 ± 2.1
p3 416.5 ± 24.9
p4 312.4 ± 3.4
p5 82.05 ± 3.16
p6 335.3 ± 24.8
p7 642.1 ± 40.4
p8 163.5 ± 37.5

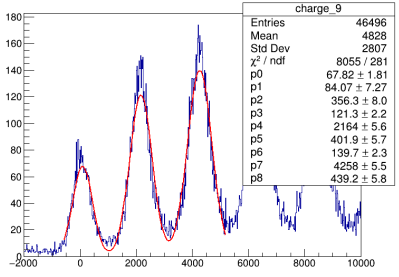


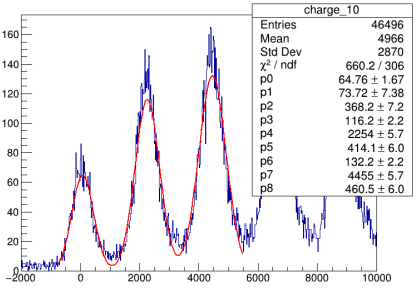



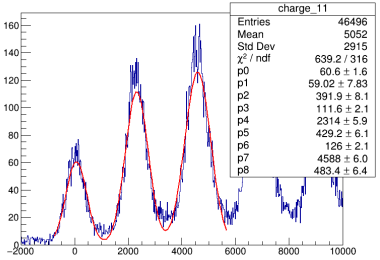



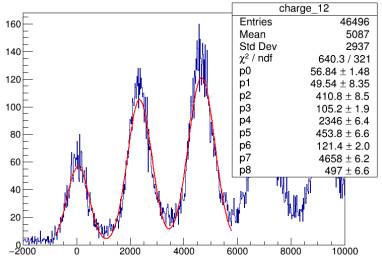



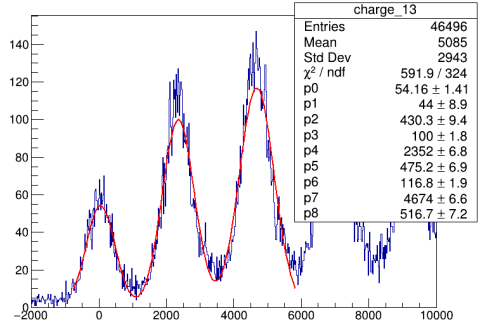



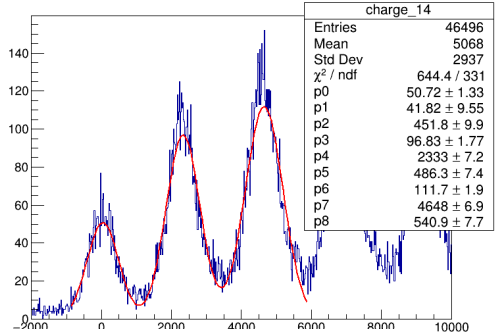



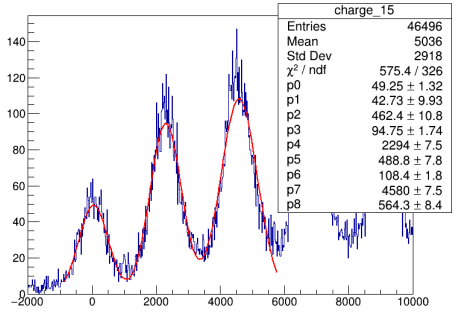

HD run 24037
fits:
Width =
5+index*5

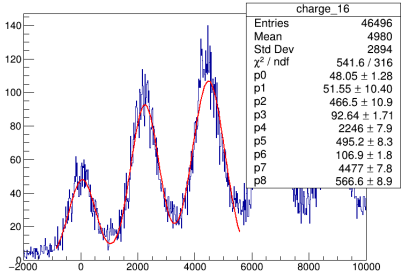
charge _3⇒

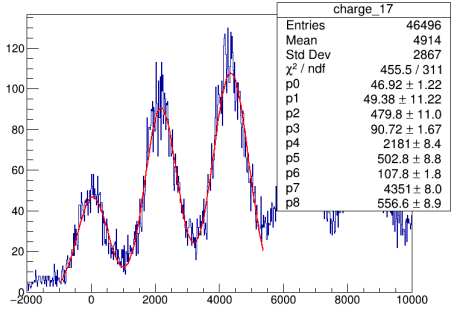
width = 5+3*5=20

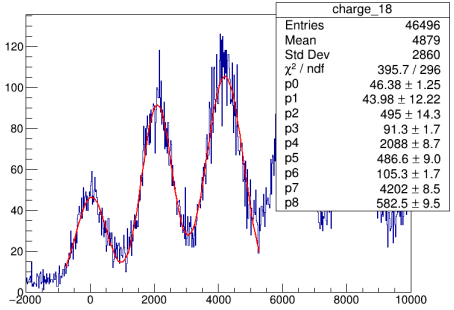


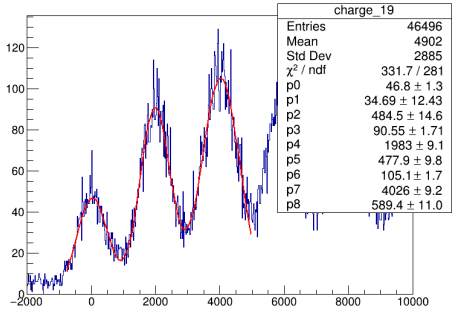



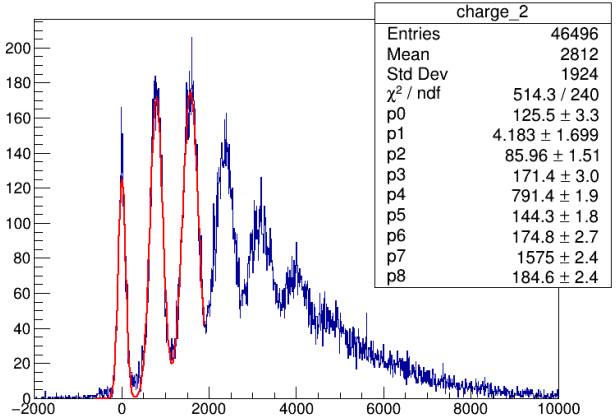



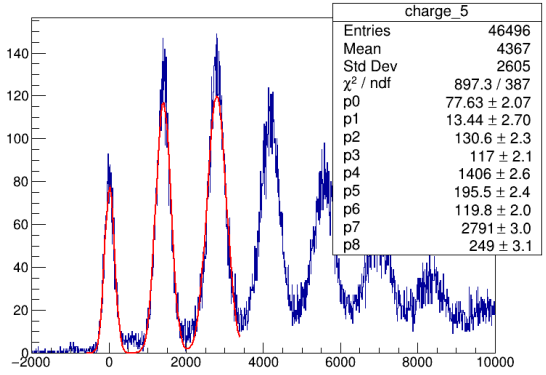



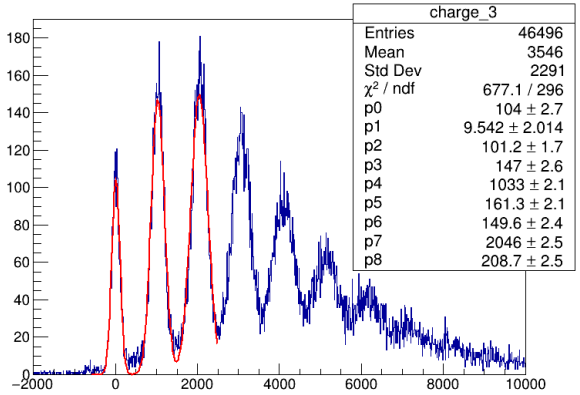



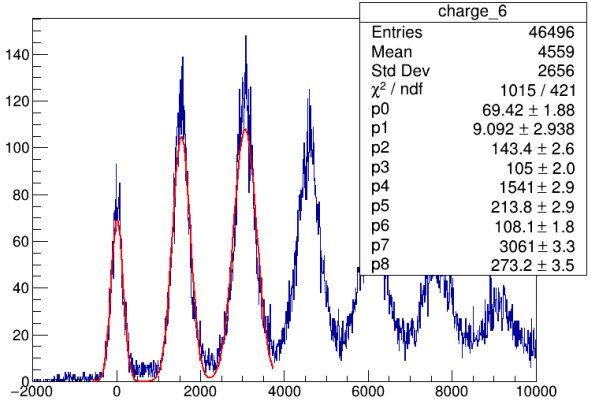

HD run 24037
fits:

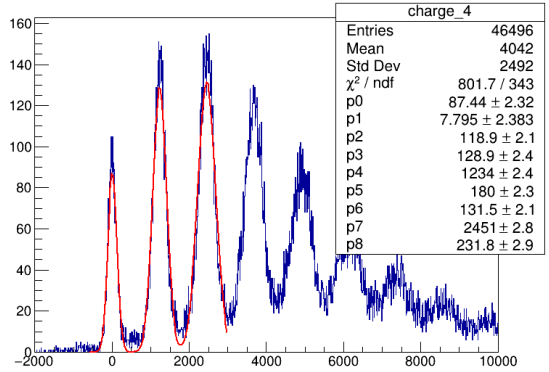
# VD (24037)

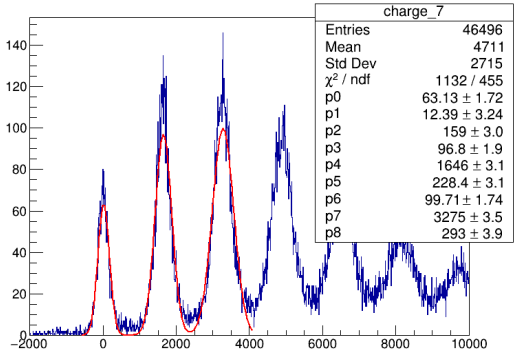

charge_2
Entries 46496
Mean 2812
Std Dev 1924
χ² / ndf 514.3 / 240
p0 125.5 ± 3.3
p1 4.183 ± 1.699
p2 85.96 ± 1.51
p3 171.4 ± 3.0
p4 791.4 ± 1.9
p5 144.3 ± 1.8
p6 174.8 ± 2.7
p7 1575 ± 2.4
p8 184.6 ± 2.4


charge_5
Entries 46496
Mean 4367
Std Dev 2605
χ² / ndf 897.3 / 387
p0 77.63 ± 2.07
p1 13.44 ± 2.70
p2 130.6 ± 2.3
p3 117 ± 2.1
p4 1406 ± 2.6
p5 195.5 ± 2.4
p6 119.8 ± 2.0
p7 2791 ± 3.0
p8 249 ± 3.1

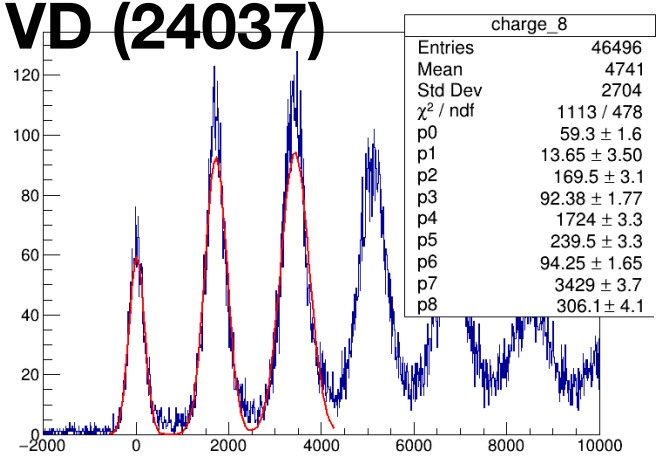

charge_3
Entries 46496
Mean 3546
Std Dev 2291
χ² / ndf 677.1 / 296
p0 104 ± 2.7
p1 9.542 ± 2.014
p2 101.2 ± 1.7
p3 147 ± 2.6
p4 1033 ± 2.1
p5 161.3 ± 2.1
p6 149.6 ± 2.4
p7 2046 ± 2.5
p8 208.7 ± 2.5

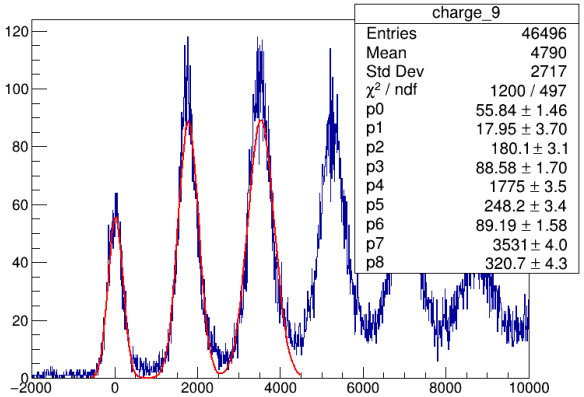

charge_6
Entries 46496
Mean 4559
Std Dev 2656
χ² / ndf 1015 / 421
p0 69.42 ± 1.88
p1 9.092 ± 2.938
p2 143.4 ± 2.6
p3 105 ± 2.0
p4 1541 ± 2.9
p5 213.8 ± 2.9
p6 108.1 ± 1.8
p7 3061 ± 3.3
p8 273.2 ± 3.5

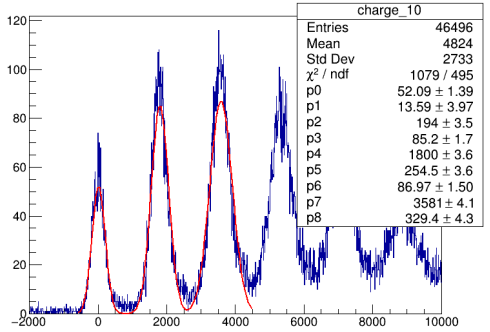

charge_4
Entries 46496
Mean 4042
Std Dev 2492
χ² / ndf 801.7 / 343
p0 87.44 ± 2.32
p1 7.795 ± 2.383
p2 118.9 ± 2.1
p3 128.9 ± 2.4
p4 1234 ± 2.4
p5 180 ± 2.3
p6 131.5 ± 2.1
p7 2451 ± 2.8
p8 231.8 ± 2.9

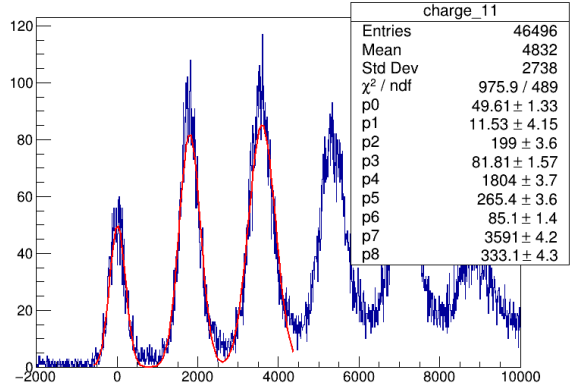

charge_7
Entries 46496
Mean 4711
Std Dev 2715
χ² / ndf 1132 / 455
p0 63.13 ± 1.72
p1 12.39 ± 3.24
p2 159 ± 3.0
p3 96.8 ± 1.9
p4 1646 ± 3.1
p5 228.4 ± 3.1
p6 99.71 ± 1.74
p7 3275 ± 3.5
p8 293 ± 3.9

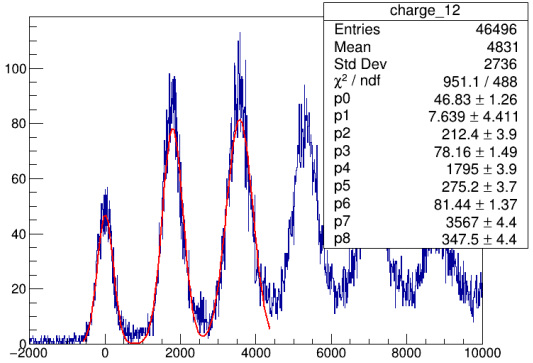
# VD (24037)

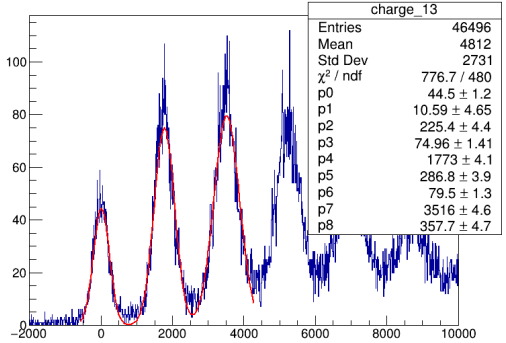

charge_8
Entries 46496
Mean 4741
Std Dev 2704
χ² / ndf 1113 / 478
p0 59.3 ± 1.6
p1 13.65 ± 3.50
p2 169.5 ± 3.1
p3 92.38 ± 1.77
p4 1724 ± 3.3
p5 239.5 ± 3.3
p6 94.25 ± 1.65
p7 3429 ± 3.7
p8 306.1 ± 4.1


charge_9
Entries 46496
Mean 4790
Std Dev 2717
χ² / ndf 1200 / 497
p0 55.84 ± 1.46
p1 17.95 ± 3.70
p2 180.1 ± 3.1
p3 88.58 ± 1.70
p4 1775 ± 3.5
p5 248.2 ± 3.4
p6 89.19 ± 1.58
p7 3531 ± 4.0
p8 320.7 ± 4.3

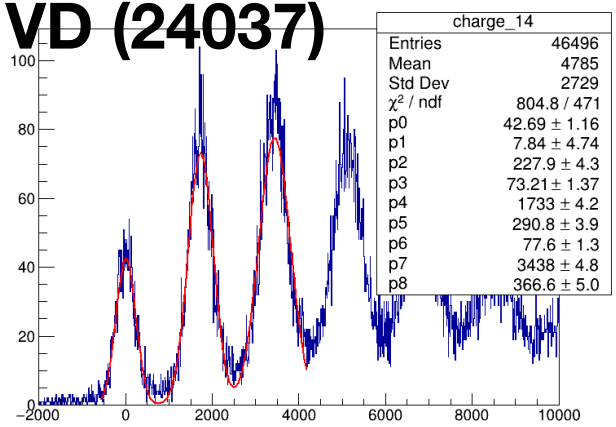

charge_10
Entries 46496
Mean 4824
Std Dev 2733
χ² / ndf 1079 / 495
p0 52.09 ± 1.39
p1 13.59 ± 3.97
p2 194 ± 3.5
p3 85.2 ± 1.7
p4 1800 ± 3.6
p5 254.5 ± 3.6
p6 86.97 ± 1.50
p7 3581 ± 4.1
p8 329.4 ± 4.3

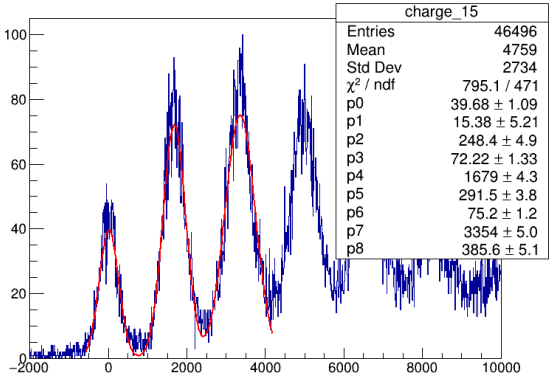

charge_11
Entries 46496
Mean 4832
Std Dev 2738
χ² / ndf 975.9 / 489
p0 49.61 ± 1.33
p1 11.53 ± 4.15
p2 199 ± 3.6
p3 81.81 ± 1.57
p4 1804 ± 3.7
p5 265.4 ± 3.6
p6 85.1 ± 1.4
p7 3591 ± 4.2
p8 333.1 ± 4.3

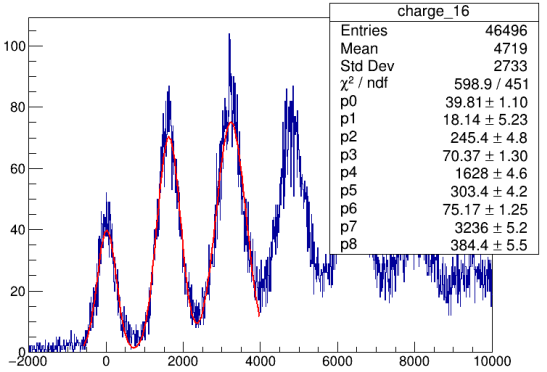

charge_12
Entries 46496
Mean 4831
Std Dev 2736
χ² / ndf 951.1 / 488
p0 46.83 ± 1.26
p1 7.639 ± 4.411
p2 212.4 ± 3.9
p3 78.16 ± 1.49
p4 1795 ± 3.9
p5 275.2 ± 3.7
p6 81.44 ± 1.37
p7 3567 ± 4.4
p8 347.5 ± 4.4

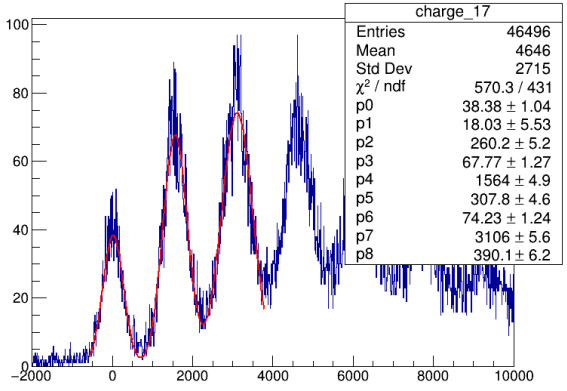

charge_13
Entries 46496
Mean 4812
Std Dev 2731
χ² / ndf 776.7 / 480
p0 44.5 ± 1.2
p1 10.59 ± 4.65
p2 225.4 ± 4.4
p3 74.96 ± 1.41
p4 1773 ± 4.1
p5 286.8 ± 3.9
p6 79.5 ± 1.3
p7 3516 ± 4.6
p8 357.7 ± 4.7

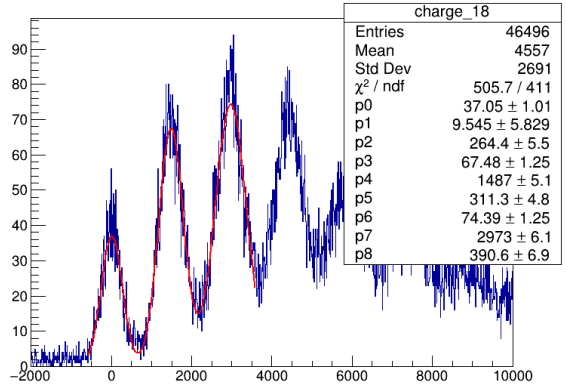
# VD (24037)

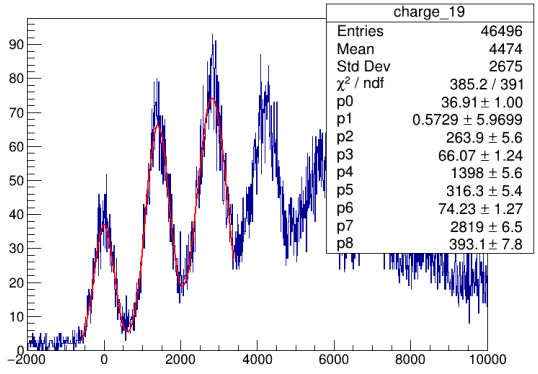

charge_14
Entries 46496
Mean 4785
Std Dev 2729
χ² / ndf 804.8 / 471
p0 42.69 ± 1.16
p1 7.84 ± 4.74
p2 227.9 ± 4.3
p3 73.21 ± 1.37
p4 1733 ± 4.2
p5 290.8 ± 3.9
p6 77.6 ± 1.3
p7 3438 ± 4.8
p8 366.6 ± 5.0


charge_15
Entries 46496
Mean 4759
Std Dev 2734
χ² / ndf 795.1 / 471
p0 39.68 ± 1.09
p1 15.38 ± 5.21
p2 248.4 ± 4.9
p3 72.22 ± 1.33
p4 1679 ± 4.3
p5 291.5 ± 3.8
p6 75.2 ± 1.2
p7 3354 ± 5.0
p8 385.6 ± 5.1

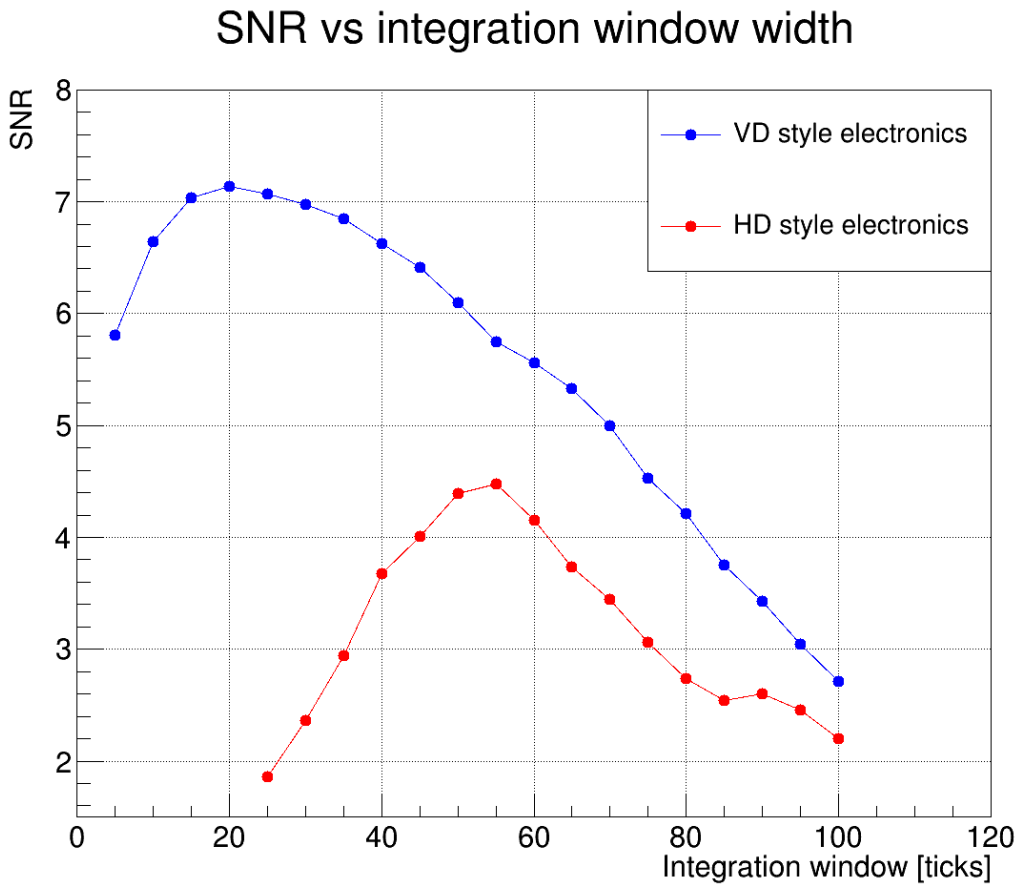

charge_16
Entries 46496
Mean 4719
Std Dev 2733
χ² / ndf 598.9 / 451
p0 39.81 ± 1.10
p1 18.14 ± 5.23
p2 245.4 ± 4.8
p3 70.37 ± 1.30
p4 1628 ± 4.6
p5 303.4 ± 4.2
p6 75.17 ± 1.25
p7 3236 ± 5.2
p8 384.4 ± 5.5


charge_17
Entries 46496
Mean 4646
Std Dev 2715
χ² / ndf 570.3 / 431
p0 38.38 ± 1.04
p1 18.03 ± 5.53
p2 260.2 ± 5.2
p3 67.77 ± 1.27
p4 1564 ± 4.9
p5 307.8 ± 4.6
p6 74.23 ± 1.24
p7 3106 ± 5.6
p8 390.1 ± 6.2

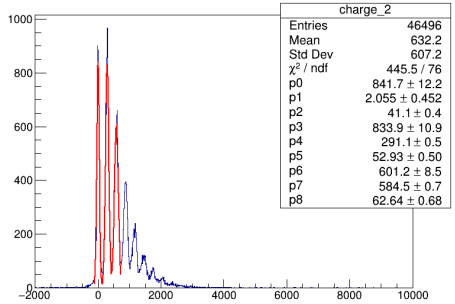

charge_18
Entries 46496
Mean 4557
Std Dev 2691
χ² / ndf 505.7 / 411
p0 37.05 ± 1.01
p1 9.545 ± 5.829
p2 264.4 ± 5.5
p3 67.48 ± 1.25
p4 1487 ± 5.1
p5 311.3 ± 4.8
p6 74.39 ± 1.25
p7 2973 ± 6.1
p8 390.6 ± 6.9

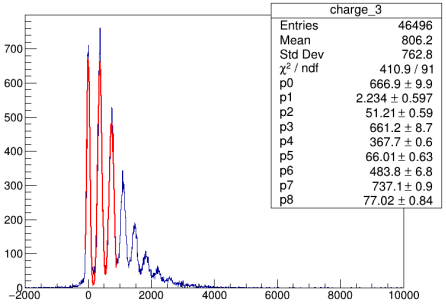

charge_19
Entries 46496
Mean 4474
Std Dev 2675
χ² / ndf 385.2 / 391
p0 36.91 ± 1.00
p1 0.5729 ± 5.9699
p2 263.9 ± 5.6
p3 66.07 ± 1.24
p4 1398 ± 5.6
p5 316.3 ± 5.4
p6 74.23 ± 1.27
p7 2819 ± 6.5
p8 393.1 ± 7.8

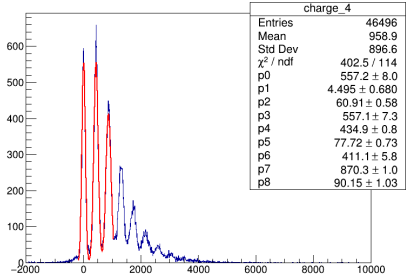
# **Run 24089 -** AFE Setting 1330

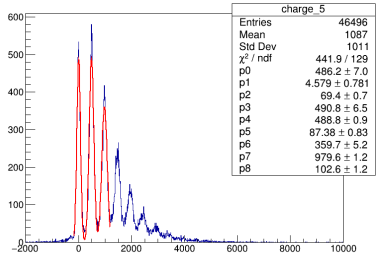


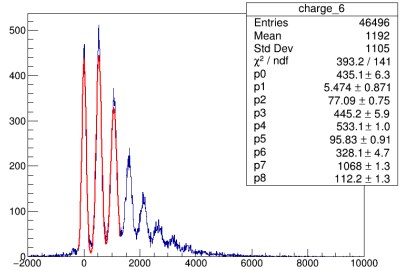
# VD 24089

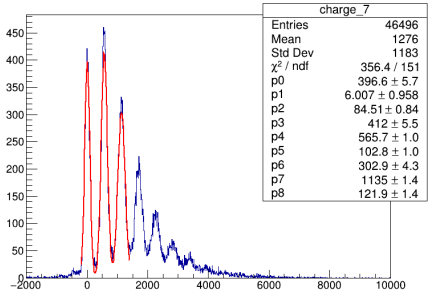

charge_2
Entries 46496
Mean 632.2
Std Dev 607.2
χ² / ndf 445.5 / 76
p0 841.7 ± 12.2
p1 2.055 ± 0.452
p2 41.1 ± 0.4
p3 833.9 ± 10.9
p4 291.1 ± 0.5
p5 52.93 ± 0.50
p6 601.2 ± 8.5
p7 584.5 ± 0.7
p8 62.64 ± 0.68

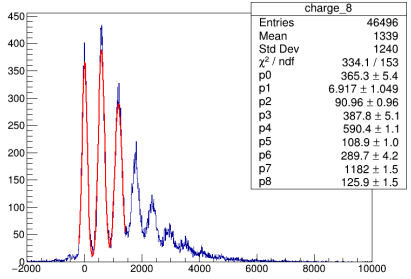

charge_3
Entries 46496
Mean 806.2
Std Dev 762.8
χ² / ndf 410.9 / 91
p0 666.9 ± 9.9
p1 2.234 ± 0.597
p2 51.21 ± 0.59
p3 661.2 ± 8.7
p4 367.7 ± 0.6
p5 66.01 ± 0.63
p6 483.8 ± 6.8
p7 737.1 ± 0.9
p8 77.02 ± 0.84

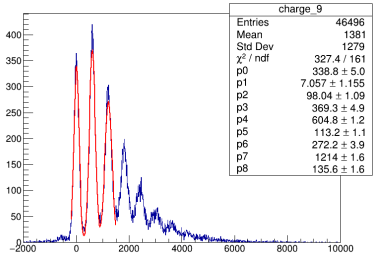

charge_4
Entries 46496
Mean 958.9
Std Dev 896.6
χ² / ndf 402.5 / 114
p0 557.2 ± 8.0
p1 4.495 ± 0.680
p2 60.91 ± 0.58
p3 557.1 ± 7.3
p4 434.9 ± 0.8
p5 77.72 ± 0.73
p6 411.1 ± 5.8
p7 870.3 ± 1.0
p8 90.15 ± 1.03

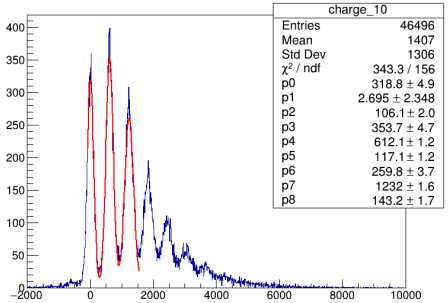

charge_5
Entries 46496
Mean 1087
Std Dev 1011
χ² / ndf 441.9 / 129
p0 486.2 ± 7.0
p1 4.579 ± 0.781
p2 69.4 ± 0.7
p3 490.8 ± 6.5
p4 488.8 ± 0.9
p5 87.38 ± 0.83
p6 359.7 ± 5.2
p7 979.6 ± 1.2
p8 102.6 ± 1.2

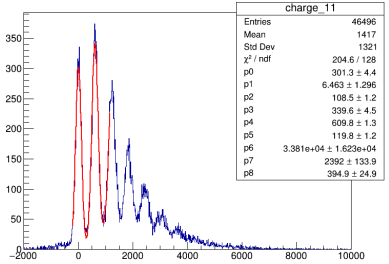

charge_6
Entries 46496
Mean 1192
Std Dev 1105
χ² / ndf 393.2 / 141
p0 435.1 ± 6.3
p1 5.474 ± 0.871
p2 77.09 ± 0.75
p3 445.2 ± 5.9
p4 533.1 ± 1.0
p5 95.83 ± 0.91
p6 328.1 ± 4.7
p7 1068 ± 1.3
p8 112.2 ± 1.3

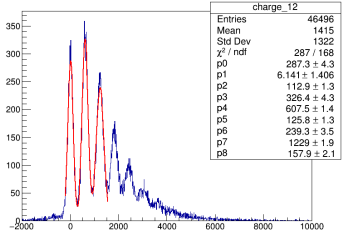

charge_7
Entries 46496
Mean 1276
Std Dev 1183
χ² / ndf 356.4 / 151
p0 396.6 ± 5.7
p1 6.007 ± 0.958
p2 84.51 ± 0.84
p3 412 ± 5.5
p4 565.7 ± 1.0
p5 102.8 ± 1.0
p6 302.9 ± 4.3
p7 1135 ± 1.4
p8 121.9 ± 1.4

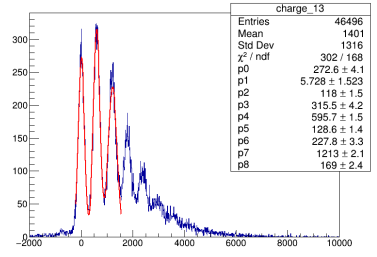

charge_8
Entries 46496
Mean 1339
Std Dev 1240
χ² / ndf 334.1 / 153
p0 365.3 ± 5.4
p1 6.917 ± 1.049
p2 90.96 ± 0.96
p3 387.8 ± 5.1
p4 590.4 ± 1.1
p5 108.9 ± 1.0
p6 289.7 ± 4.2
p7 1182 ± 1.5
p8 125.9 ± 1.5


charge_9
Entries 46496
Mean 1381
Std Dev 1279
χ² / ndf 327.4 / 161
p0 338.8 ± 5.0
p1 7.057 ± 1.155
p2 98.04 ± 1.09
p3 369.3 ± 4.9
p4 604.8 ± 1.2
p5 113.2 ± 1.1
p6 272.2 ± 3.9
p7 1214 ± 1.6
p8 135.6 ± 1.6

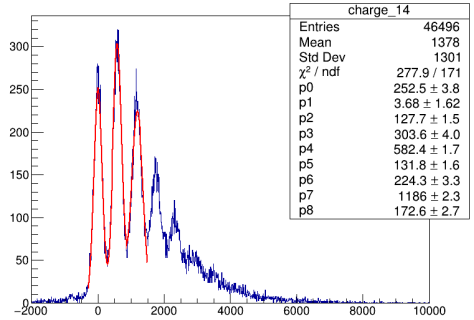

charge_10
Entries 46496
Mean 1407
Std Dev 1306
χ² / ndf 343.3 / 156
p0 318.8 ± 4.9
p1 2.695 ± 2.348
p2 106.1 ± 2.0
p3 353.7 ± 4.7
p4 612.1 ± 1.2
p5 117.1 ± 1.2
p6 259.8 ± 3.7
p7 1232 ± 1.6
p8 143.2 ± 1.7

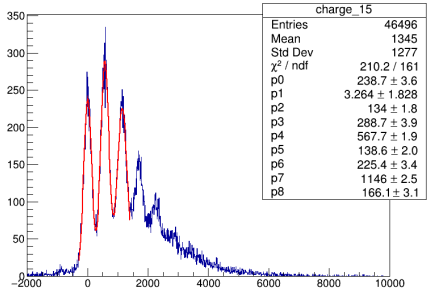

charge_11
Entries 46496
Mean 1417
Std Dev 1321
χ² / ndf 204.6 / 128
p0 301.3 ± 4.4
p1 6.463 ± 1.296
p2 108.5 ± 1.2
p3 339.6 ± 4.5
p4 609.8 ± 1.3
p5 119.8 ± 1.2
p6 3.381e+04 ± 1.623e+04
p7 2392 ± 133.9
p8 394.9 ± 24.9

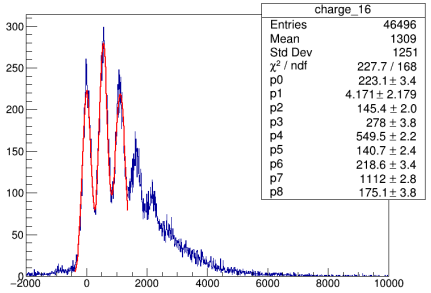

charge_12
Entries 46496
Mean 1415
Std Dev 1322
χ² / ndf 287 / 168
p0 287.3 ± 4.3
p1 6.141 ± 1.406
p2 112.9 ± 1.3
p3 326.4 ± 4.3
p4 607.5 ± 1.4
p5 125.8 ± 1.3
p6 239.3 ± 3.5
p7 1229 ± 1.9
p8 157.9 ± 2.1

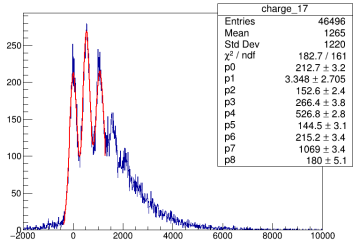

charge_13
Entries 46496
Mean 1401
Std Dev 1316
χ² / ndf 302 / 168
p0 272.6 ± 4.1
p1 5.728 ± 1.523
p2 118 ± 1.5
p3 315.5 ± 4.2
p4 595.7 ± 1.5
p5 128.6 ± 1.4
p6 227.8 ± 3.3
p7 1213 ± 2.1
p8 169 ± 2.4

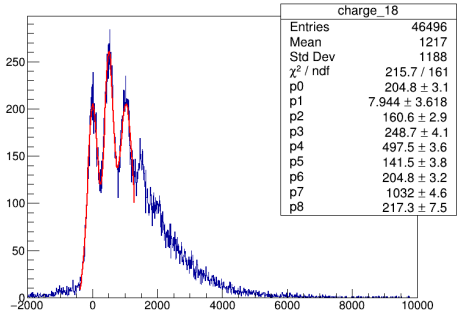
# VD 24089

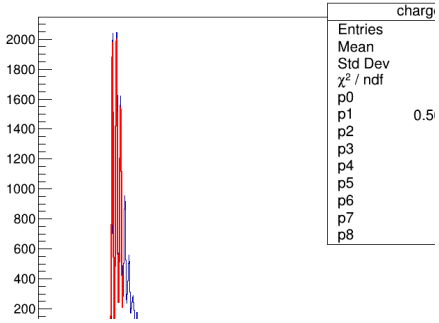

charge_14
Entries 46496
Mean 1378
Std Dev 1301
χ² / ndf 277.9 / 171
p0 252.5 ± 3.8
p1 3.68 ± 1.62
p2 127.7 ± 1.5
p3 303.6 ± 4.0
p4 582.4 ± 1.7
p5 131.8 ± 1.6
p6 224.3 ± 3.3
p7 1186 ± 2.3
p8 172.6 ± 2.7

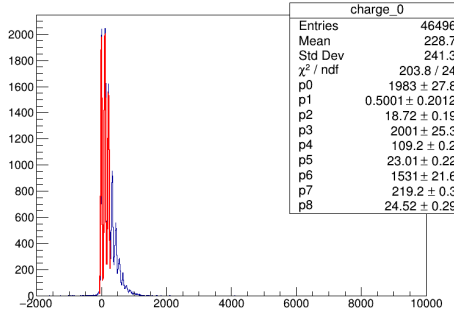

charge_15
Entries 46496
Mean 1345
Std Dev 1277
χ² / ndf 210.2 / 161
p0 238.7 ± 3.6
p1 3.264 ± 1.828
p2 134 ± 1.8
p3 288.7 ± 3.9
p4 567.7 ± 1.9
p5 138.6 ± 2.0
p6 225.4 ± 3.4
p7 1146 ± 2.5
p8 166.1 ± 3.1

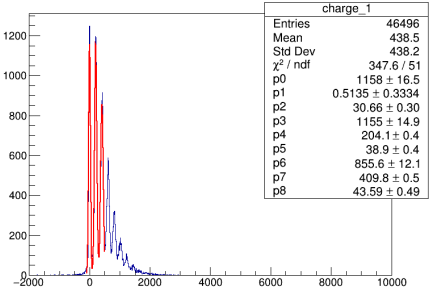

charge_16
Entries 46496
Mean 1309
Std Dev 1251
χ² / ndf 227.7 / 168
p0 223.1 ± 3.4
p1 4.171 ± 2.179
p2 145.4 ± 2.0
p3 278 ± 3.8
p4 549.5 ± 2.2
p5 140.7 ± 2.4
p6 218.6 ± 3.4
p7 1112 ± 2.8
p8 175.1 ± 3.8


charge_17
Entries 46496
Mean 1265
Std Dev 1220
χ² / ndf 182.7 / 161
p0 212.7 ± 3.2
p1 3.348 ± 2.705
p2 152.6 ± 2.4
p3 266.4 ± 3.8
p4 526.8 ± 2.8
p5 144.5 ± 3.1
p6 215.2 ± 3.4
p7 1069 ± 3.4
p8 180 ± 5.1

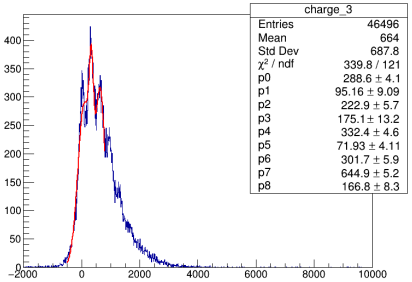

charge_18
Entries 46496
Mean 1217
Std Dev 1188
χ² / ndf 215.7 / 161
p0 204.8 ± 3.1
p1 7.944 ± 3.618
p2 160.6 ± 2.9
p3 248.7 ± 4.1
p4 497.5 ± 3.6
p5 141.5 ± 3.8
p6 204.8 ± 3.2
p7 1032 ± 4.6
p8 217.3 ± 7.5

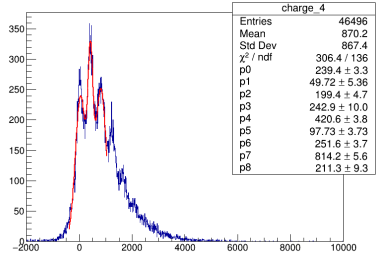

charg
Entries
Mean
Std Dev
χ² / ndf
p0
p1 0.5
p2
p3
p4
p5
p6
p7
p8

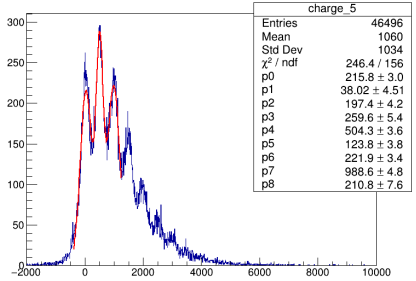

charge_0
Entries 46496
Mean 228.7
Std Dev 241.3
χ² / ndf 203.8 / 24
p0 1983 ± 27.8
p1 0.5001 ± 0.2012
p2 18.72 ± 0.19
p3 2001 ± 25.3
p4 109.2 ± 0.2
p5 23.01 ± 0.22
p6 1531 ± 21.6
p7 219.2 ± 0.3
p8 24.52 ± 0.29

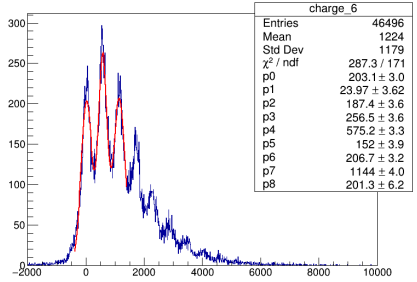

charge_1
Entries 46496
Mean 438.5
Std Dev 438.2
χ² / ndf 347.6 / 51
p0 1158 ± 16.5
p1 0.5135 ± 0.3334
p2 30.66 ± 0.30
p3 1155 ± 14.9
p4 204.1 ± 0.4
p5 38.9 ± 0.4
p6 855.6 ± 12.1
p7 409.8 ± 0.5
p8 43.59 ± 0.49

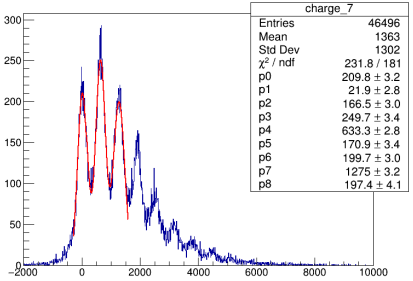
# HD 24089

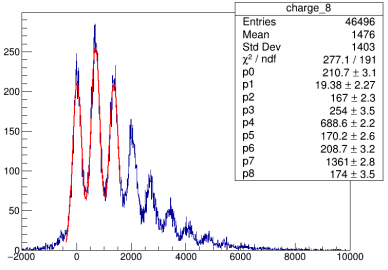

charge_3
Entries 46496
Mean 664
Std Dev 687.8
χ² / ndf 339.8 / 121
p0 288.6 ± 4.1
p1 95.16 ± 9.09
p2 222.9 ± 5.7
p3 175.1 ± 13.2
p4 332.4 ± 4.6
p5 71.93 ± 4.11
p6 301.7 ± 5.9
p7 644.9 ± 5.2
p8 166.8 ± 8.3

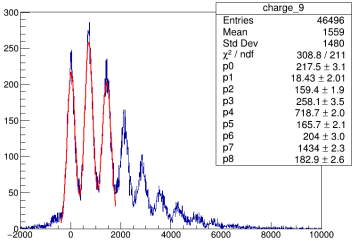

charge_4
Entries 46496
Mean 870.2
Std Dev 867.4
χ² / ndf 306.4 / 136
p0 239.4 ± 3.3
p1 49.72 ± 5.36
p2 199.4 ± 4.7
p3 242.9 ± 10.0
p4 420.6 ± 3.8
p5 97.73 ± 3.73
p6 251.6 ± 3.7
p7 814.2 ± 5.6
p8 211.3 ± 9.3

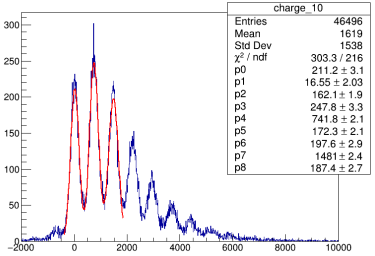

charge_5
Entries 46496
Mean 1060
Std Dev 1034
χ² / ndf 246.4 / 156
p0 215.8 ± 3.0
p1 38.02 ± 4.51
p2 197.4 ± 4.2
p3 259.6 ± 5.4
p4 504.3 ± 3.6
p5 123.8 ± 3.8
p6 221.9 ± 3.4
p7 988.6 ± 4.8
p8 210.8 ± 7.6

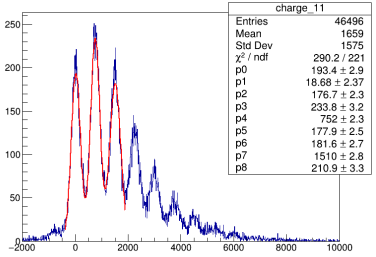

charge_6
Entries 46496
Mean 1224
Std Dev 1179
χ² / ndf 287.3 / 171
p0 203.1 ± 3.0
p1 23.97 ± 3.62
p2 187.4 ± 3.6
p3 256.5 ± 3.6
p4 575.2 ± 3.3
p5 152 ± 3.9
p6 206.7 ± 3.2
p7 1144 ± 4.0
p8 201.3 ± 6.2


charge_7
Entries 46496
Mean 1363
Std Dev 1302
χ² / ndf 231.8 / 181
p0 209.8 ± 3.2
p1 21.9 ± 2.8
p2 166.5 ± 3.0
p3 249.7 ± 3.4
p4 633.3 ± 2.8
p5 170.9 ± 3.4
p6 199.7 ± 3.0
p7 1275 ± 3.2
p8 197.4 ± 4.1


charge_8
Entries 46496
Mean 1476
Std Dev 1403
χ² / ndf 277.1 / 191
p0 210.7 ± 3.1
p1 19.38 ± 2.27
p2 167 ± 2.3
p3 254 ± 3.5
p4 688.6 ± 2.2
p5 170.2 ± 2.6
p6 208.7 ± 3.2
p7 1361 ± 2.8
p8 174 ± 3.5

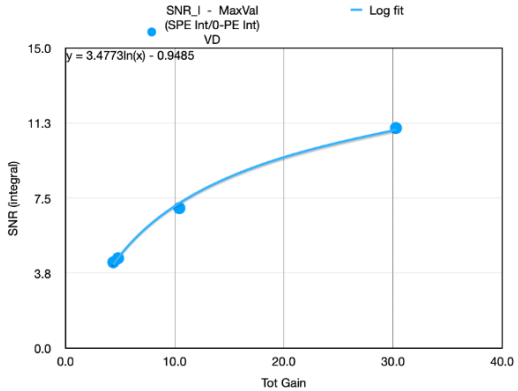

charge_9
Entries 46496
Mean 1559
Std Dev 1480
χ² / ndf 308.8 / 211
p0 217.5 ± 3.1
p1 18.43 ± 2.01
p2 159.4 ± 1.9
p3 258.1 ± 3.5
p4 718.7 ± 2.0
p5 165.7 ± 2.1
p6 204 ± 3.0
p7 1434 ± 2.3
p8 182.9 ± 2.6


charge_10
Entries 46496
Mean 1619
Std Dev 1538
χ² / ndf 303.3 / 216
p0 211.2 ± 3.1
p1 16.55 ± 2.03
p2 162.1 ± 1.9
p3 247.8 ± 3.3
p4 741.8 ± 2.1
p5 172.3 ± 2.1
p6 197.6 ± 2.9
p7 1481 ± 2.4
p8 187.4 ± 2.7

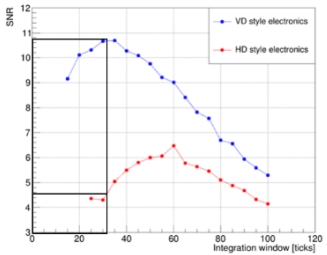

charge_11
Entries 46496
Mean 1659
Std Dev 1575
χ² / ndf 290.2 / 221
p0 193.4 ± 2.9
p1 18.68 ± 2.37
p2 176.7 ± 2.3
p3 233.8 ± 3.2
p4 752 ± 2.3
p5 177.9 ± 2.5
p6 181.6 ± 2.7
p7 1510 ± 2.8
p8 210.9 ± 3.3

AFE Gain & Attenuation Settings during Run

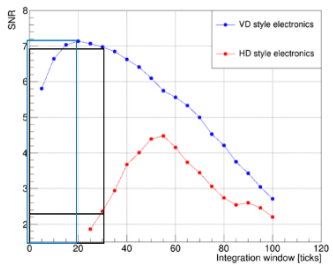
| Run # | AFE setting VGAIN [DAC] | Vcntrl [V] VGAIN 2666 = 1V Vcntrl | Tot Gain [db] LNA+VCAT+PGA (12db+VCAT+24db) | Atten [db] VCAT (only) | Tot Gain factor (db->Out/In) | Atten factor (db->Out/In) | SNR_I - (32ticks) (SPE Int/0-PE Int) VD | SNR_I - (32ticks) (SPE Int/0-PE Int) HD | SNR_I - MaxVal (SPE Int/0-PE Int) VD |
|---|---|---|---|---|---|---|---|---|---|
| 24037 | 600 | 0.23 | 29.6 | -6.4 | 30.3 | 0.48 | 10.8 | 4.4 | 11.0 |
| 24089 | 1330 | 0.50 | 20.4 | -15.6 | 10.4 | 0.17 | 7.0 | 2.4 | 7.0 |
| 24097 | 1860 | 0.70 | 13.6 | -22.4 | 4.8 | 0.08 | 4.3 | 2.3 | 4.5 |
| 24062 | 1925 | 0.72 | 12.8 | -23.2 | 4.4 | 0.07 | 4.1 | 3.4 | 4.3 |
| | | | | | | | | | |



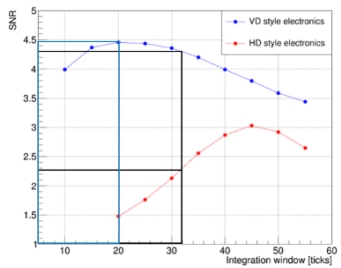

**Run 24037** - AFE Setting 600




**Run 24089** - AFE Setting 1330




**Run 24097** - AFE Setting 1860




**Run 24062** - AFE Setting 1925